Tropical Products Institute

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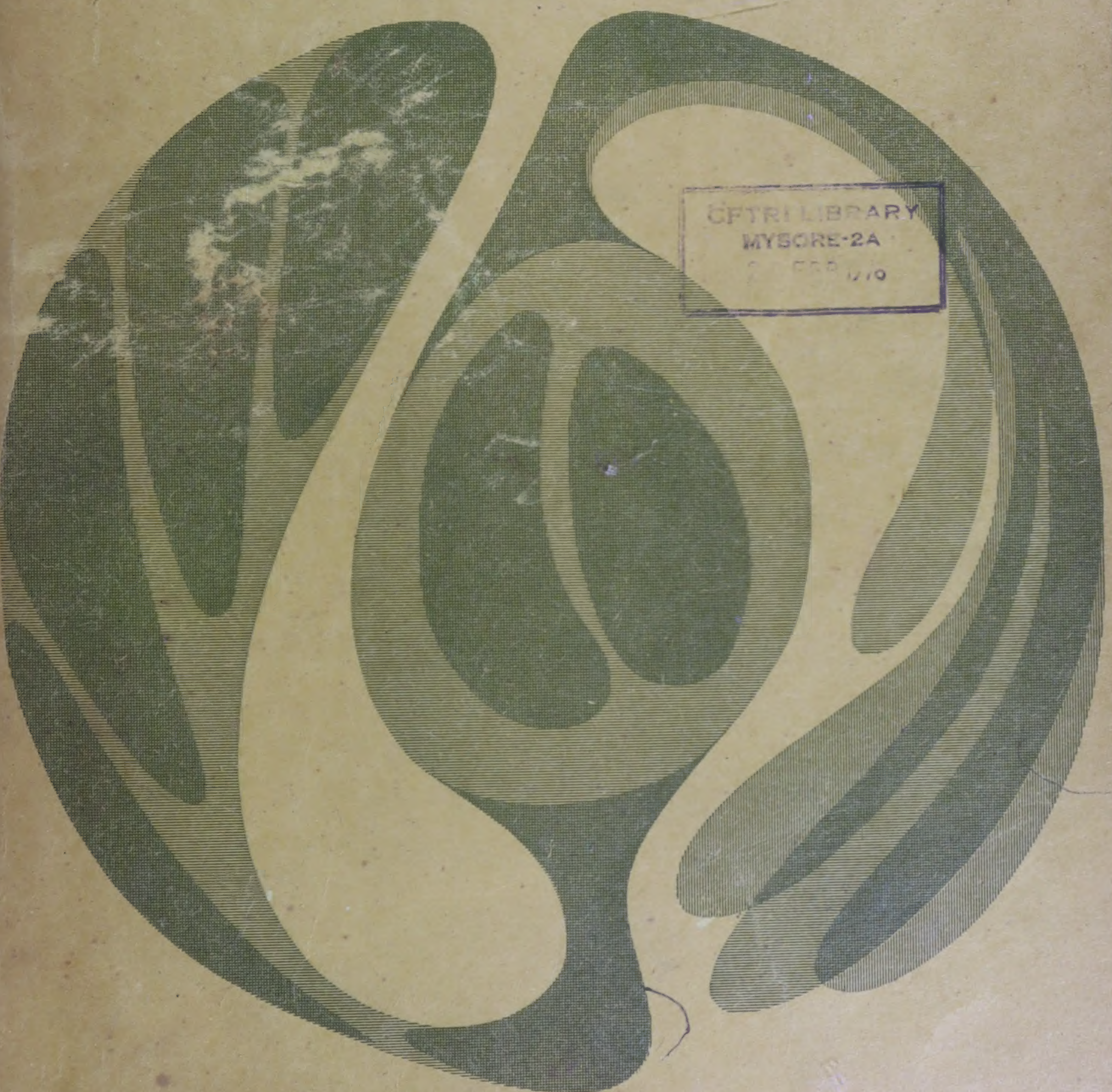
The market for dried, preserved and fresh ginger



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The market for dried, preserved and fresh ginger

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Ministry of Overseas Development

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It specialises in post-harvest problems and will be pleased to answer requests for information and advice.

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Summaries

SUMMARY

This report considers developments in the market for dried, preserved and fresh ginger since the publication in 1964 of TPI Report G8, *The Market for dried, preserved and fresh ginger.* The report is divided into three sections, each dealing with a separate product. It includes statistical tables setting out the main trends in exports and imports for each relevant country.

The most important market remains that for dried ginger. For this product the major markets are the UK and USA, although some European countries and the countries of the Middle East and North Africa are also important. While there has been some growth in markets this has tended to level off in the last few years. Trade sources are not particularly optimistic regarding the prospects for any future supplier. The main change in exporting countries has been the rise in importance of Nigeria and the decline of Sierra Leone and Jamaica, as well as the firm establishment of one or two other producers.

The UK is the main market for preserved ginger, for which there has been little growth in demand in recent years. The main suppliers are Hong Kong, China and Australia. The most notable feature of the market during the last decade has been the establishment of the last-mentioned as producer and exporter; there has been a movement away from the products of the other two countries in favour of supplies from Australia. This has been achieved on the basis of the production of a more expensive product of better quality, backed by the application of research findings. The product has been developed to meet the specific requirements of large industrial users. Prospects for new entrants to the market in the face of this well-organised competition are considered to be very poor.

Information relating to fresh ginger is not easily available. For the most part it relates to imports of green ginger into Hong Kong, to be used in the production of preserved ginger. The use of green ginger in domestic cooking is an extensive practice in many Asian countries which are, however, generally self-sufficient in ginger. The UK is a small market which is considered to be static.

RÉSUMÉ

Le marché pour le gingembre séché, conservé et frais

Dans ce rapport on étudie les développements sur le marché du gingembre séché, confit et frais depuis la publication en 1964 du rapport TPI G8, *Le marché du gingembre séché, confit et frais.* Le rapport est divisé en trois parties concernant chacune un produit particulier. Il comprend des tableaux statistiques dégageant les principales tendances des exportations et des importations pour chaque pays concerné.

Le marché le plus important reste celui du gingembre séché. Pour ce produit, les principaux marchés sont le Royaume-Uni et les Etats-Unis, bien que certains pays européens et les pays du Moyen-Orient et d'Afrique du Nord soient également importants. Bien qu'il y ait eu une certaine augmentation des marchés, elle a présenté une tendance à se stabiliser au cours des dernières années. Les sources commerciales ne sont pas particulièrement optimistes en ce qui concerne les perspectives pour tout fournisseur futur. Le principal changement pour les pays exportateurs a été l'augmentation de l'importance du Nigeria et le déclin de la Sierra Leone et de la Jamaïque, de même que le solide éstablissement d'un ou deux autres producteurs.

Le Royaume-Uni est le principal marché de gingembre confit, pour lequel la demande a peu augmenté au cours des dernières années. Les principaux fournisseurs sont Hong-Kong, la Chine et l'Australie. L'établissement de cette dernière en tant que producteur et exportateur a été le fait le plus remarquable qui se soit produit sur le marché pendant la dernière décade; il y a eu un mouvement tendant à s'éloigner des produits des deux autres pays en faveur des approvisionnements venant d'Australie. Ceci s'est réalisé sur la base de la production d'un produit plus cher de meilleure qualité, s'appuyant sur l'application de résultats de recherches. Le produit a été développé pour satisfaire aux besoins spécifiques d'importants utilisateurs industriels. On considère que les perspectives pour de nouveaux candidats à entrer sur le marché sont très faibles, compte tenu de cette compétition bien organisée.

Les informations concernant le gingembre frais ne sont pas faciles à obtenir. Pour la majeure partie, il s'agit d'importations de gingembre vert à Hong-Kong en vue de la production de gingembre confit. L'emploi de gingembre vert dans la cuisine familiale est une coutume répandue dans de nombreux pays d'Asie qui, cependant, se suffisent généralement à eux-même en ce qui concerne le gingembre. Le Royaume-Uni constitue un marché peu important qui est considéré comme étant stationnaire.

RESUMEN

El mercado de jengibre secado, conservado y fresco

Este informe trata del desarrollo habido en el mercado de jengibre fresco, en conserva y seco, desde la publicación en 1964 del TPI Report G8, 'The Market for dried, preserved and fresh ginger' (El Mercado de jengibre fresco, en conserva y seco). El informe está dividido en tres secciones, tratando separadamente cada una de las mismas de uno de estos tres productos. Incluye cuadros estadísticos que muestran las tendencias principales en las importaciones y exportaciones de los países más importantes.

El mercado más importante continua siendo el de jengibre seco. Los principales mercados de este producto son el Reino Unido y los Estados Unidos, aunque algunos países europeos y los países del Oriente Medio y Africa del Norte también tienen importancia. Aunque ha habido algún crecimiento en los mercados, en los últimos años existe la tendencia a su establización. Las informaciones commerciales no son especialmente optimistas en cuanto a las perspectivas para cualquier futuro suministrador. El cambio principal en los países exportadores ha sido el aumento de la importancia de Nigeria y el declive de Sierra Leona y Jamaica, así como el firme establecimiento de uno o dos otros países productores.

El Reino Unido es el mercado principal de jengibre en conserva, habiéndose producido un ligero crecimiento de la demanda en los años recientes. Los principales suministradores son Hong Kong, China y Australia. La característica más notable del mercado durante la última década ha sido el establecimiento de este último país como productor y exportador; ha habido un movimiento de la demanda de productos de los otros dos países en favor de los suministros procedentes de Australia. Esto se ha conseguido a base de la producción de un producto más

caro y de mejor calidad, fundada en la aplicación de logros de investigación. El producto se ha desarrollado de acuerdo con las necesidades especificas de los grandes clientes industriales. Debido a esta competencia bien organizada, las perspectivas de entrada en el mercado de nuevos exportadores se consideran muy pobres.

No es fácil disponer de información relativa al jengibre fresco. En la mayoría de los casos se refiere a las importaciones en Hong Kong del jengibre verde, que se va a usar en la producción de jengibre en conserva. El uso de jengibre verde en la cocina doméstica es una práctica muy extendida en muchos países asiáticos, los cuales son generalmente, sin embargo, autosuficientes en jengibre. El Reino Unido constituye un mercado pequeño que se considera estático.

Introduction

The purpose of this report is to update the information contained in TPI Report G8 (1964) *The market for dried, preserved and fresh ginger,* now out-of-print, and to consider any new developments in the market for these products. Trends in price movements and the volume imported by the major importing countries will be established; the pattern of use of ginger and any major change in this pattern will be considered. The major exporting countries will be identified, the opportunities for expansion of trade by these countries will be considered and the scope for new entrants to the markets will be discussed.

Ginger is grown over a wide area of the tropics, although the major areas of production are in Southern and Eastern Asia. It is an annual crop which is reproduced by means of cuttings from the rhizome. As such it is possible for producers to make a relatively quicker response to price movements than would be the case with certain other spices. It is a crop which makes heavy demands on labour during cultivation and can exhaust soils. The soil in which it is grown should be rich in plant food unless manures are readily and cheaply available.

Although it is possible to export ginger in more than one form and the markets for the different forms are distinct, nearly all the ginger in commerce comes from one variety of the ginger plant: *Zingiber officinale* Roscoe. The only exception is *Zingiber mioga* Roscoe which is grown in Japan. The most important form in which ginger enters international trade is as a dried product. The trade in preserved ginger is next in importance and that in fresh ginger is of least significance, although there is a considerable import into Hong Kong from China and Taiwan for processing into preserved ginger for subsequent export.

There is some specialisation with respect to production and trade, arising from the differing quality and characteristics of the ginger grown in each country and the existence of preferences on the part of importers and manufacturers. Hence these forms (dried, preserved and fresh ginger) are not necessarily alternative products for the producing country and no one country necessarily exports ginger in all three forms. Moreover, a great deal of the ginger produced does not enter international trade but is consumed in the domestic market of the producing country. This is particularly the situation in the countries of Southern and Eastern Asia, within which ginger has a wide range of culinary uses.

The general direction of international trade is from the tropical and semi-tropical regions to the European and North American markets. However, the countries of the Middle East and North Africa are an important exception and it is among these countries that the highest per capita consumption of ginger is to be found.

These three forms in which ginger enters international trade will be given detailed and separate treatment in the sections which follow.

Dried ginger

The product traded as dried ginger consists of the ginger rhizome after it has been dried in the country of production. The dried ginger from the various exporting countries differs with respect to method of preparation, appearance, pungency and flavour. It is generally imported in either the whole or the split form; in the case of the UK very little is imported in the ground state as the buyers prefer to undertake the processing themselves.

To be worthy of consideration as a better quality dried ginger it is required that the product be at least in the whole peeled form. For less exacting requirements, split, partly peeled or scraped ginger is acceptable. Dried ginger is normally packed and shipped in jute or hessian sacks; the weight of these varies according to origin, but usually lies within the range of 50 to 100 kg.

USES

The main use of dried ginger has been as a flavouring material in the food industry. The other main outlets are the perfumery and pharmacy industries. It has been estimated for the UK that 95% or more of the dried ginger going to the spice milling industry is destined for use in the food industry; the remainder goes to the other two industries mentioned above. As a flavouring ginger, like many other spices, can be applied in more than one form. These are ground ginger, ginger oil and ginger oleoresin.

The traditional form of application has been that of ground ginger. This is also the product which is retailed through the grocery trade for domestic cooking purposes. At present, however, by far the largest consumer of ground ginger is the processed and prepared foods sector, which has increased its share of the food market in the UK, USA and European countries. Dried ginger for grinding is handled by brokers and the large spice milling concerns which supply the requirements of the food processors.

The section of the food industry which is the most important outlet for ginger is the bakery industry, in particular manufacturers of biscuits and cakes. The other users are manufacturers of confectionery, soups and other pre-cooked canned foods, soft drinks, pickles and chutneys, and meat processors. It is also used to spice pet foods.

The application of ground ginger has had a number of disadvantages for the food processors. During the last decade the main change in the pattern of trade has not been in the structure of industries using it, but rather in the channels through which it reaches these industries. There has been a movement away from ground spices generally towards use of the essential oil and oleoresin, particularly the latter. The reasons for this are expanded on below. A substantial research and marketing effort was put into the production of these products and since the mid-1960's consumption has expanded rapidly although it has now slowed down somewhat as the scope for substitution for ground spices diminishes.

For spices generally it is estimated that 60% of all spice material currently used by UK food manufactures is in the form of oleoresin, compared to an estimate for 1960 of around 10%. It is not possible to derive similar figures which relate solely to ginger.

Ginger volatile oil contains the aroma principles, but not the pungency. It is obtained by steam distillation of ground ginger. The main applications are in confectionery and beverage flavouring and in baked products; there is also a small outlet in the perfumery industry, particularly in certain cosmetics for men. A limited amount of ginger oil may be added to the oleoresin to restore balance between aroma and pungency.

As well as being produced in the UK, ginger oil is imported from a number of sources such as Singapore and the United States. One estimate has placed imports as high as 50% of UK consumption. In so far as there is this import of ginger oil, the market for dried ginger in the UK (and also in other countries which import this oil) has lessened somewhat.

Oleoresin is prepared by the extraction of ground ginger with volatile solvents. The oleoresin contains all the flavour principles including pungency, and has an essential oil content of 15–30%. Of the three forms of raw material mentioned above, the oleoresin is the most favoured form of application for flavouring and is applied to baked products, meats and sauces, blended spices and carbonated beverages. A further minor use is in the pharmaceutical trade, for instance in throat lozenges. For the United States, one source estimated that half of the dried ginger imported would be for the production of essential oil and oleoresin.

The increased consumption of oleoresin has altered the chain of distribution to the food industry. As well as brokers and spice millers, the flavour houses are now much more involved in this trade. For the food processor the oleoresin has the advantage of being more economical in use than the spice material. In addition uniformity of flavour is much easier to achieve, and the oleoresins are sterile and thus free from the bacteriological contamination, which can affect the natural spice material.

SOURCES AND SUPPLIES

In the 1960's a major alteration in the pattern of supplies took place, particularly to the large markets in the UK and the USA. Table 1 in Appendix I summarises the trend in exports for the main supplying countries. Table 2 indicates the distribution of exports from the major suppliers.

The consensus of opinion in the trade is that the dried ginger of Jamaica is still of superior quality, by virtue of its light colour, good aroma, and mellow taste. The product is marketed in the whole peeled form. The Jamaican product attracts a considerable premium in price in comparison with all other dried gingers. This premium is also a reflection of the comparative scarcity of the product in recent years due to declining harvests. Over the years 1956–60, exports of dried ginger from Jamaica averaged 820 tonnes a year; for the years 1960–64 this had declined to an average of 630 tonnes a year; by the years 1967–71 a further decline had been recorded to an average of 410 tonnes a year. The smaller harvests have been attributed in part to less interest among the growers, arising from higher labour costs, soil exhaustion and some dissatisfaction with marketing arrangements.

The direction of Jamaican exports follows the traditional pattern. The UK and the USA share the bulk of these exports between them, the latter now usually taking a higher proportion. The only other market of any importance, although of considerably less importance than the other two, is that of Canada. The product is highly regarded in the USA and there is keen interest in supplies from Jamaica.

The pharmaceutical trade is a major user of Jamaican dried ginger; this demand can be met from the smaller crops now obtained because there has been a decline in demand for it in other uses. In the UK, it is the unbleached Jamaican ginger which is specified in the *British Pharmacopoeia* for use in pharmaceutical preparations. Dried ginger is used in these as a flavouring rather than for medicinal purposes. A proportion is still used for distillation. However, the food trade now uses only a very small amount in comparison with previous quantities. In this field demand has proved to be price elastic; buyers have found lower-priced products, such as those of Nigeria, to be satisfactory alternatives and have ceased to use the Jamaican product.

The dried ginger of Jamaica is graded as follows:

No 1 — 'Bold', attractive, consisting of large, firm unwrinkled hands. Pale cream to white in colour, uniform in size, and free from blemishes or mildew. This grade is usually retailed whole through the grocery trade.

No 2 — Less uniform in size than the above but of similar colour, firm and free from blemishes or mildew.

No 3 — Small in size; may be slightly off colour.

Generally speaking, prices quoted (see below) relate to the No 3 grade; those for No 2 would be 5 to 10% higher and those for No 1, 10 to 15% higher.

India and Nigeria are the largest exporters of dried ginger. In some years India is the larger exporter of the two; in others it is Nigeria. For both countries, the export trade is complicated by the existence of a sizeable domestic market for the product. This is particularly so for India, where it is estimated that considerably more than half the crop is used on the domestic market; in some years exports may constitute no more than 25% of output.

India has long been a traditional supplier of dried ginger, although in the latter half of the 1960's there was a notable decline in exports. In the last year or two the volume of exports has reached or exceeded earlier levels.

The fluctuations in output tend not to be the result of changes in the acreage devoted to ginger, but would appear to arise from factors such as variation in yield due to changing weather conditions, particularly the monsoon rainfall.

The dried ginger of India is of two types, Cochin and Calicut, depending on the district in Southern India from which it comes. Cochin is the most commonly quoted in European and North American markets. The product is usually exported in the rough peeled or scraped form, although sometimes it is coated (unpeeled). The ginger of Cochin has a lemon-like flavour and odour and has been widely used for grinding and blending. In recent years on the London market its price has been higher than that of Nigerian split but lower than that of Sierra Leone ginger. However, the price of Nigerian split has been much closer to that of Cochin than it used to be and has moved above it at times during the last year.

Over the years 1956–60 and 1960–64 exports of dried ginger from India averaged around 5,500 tonnes a year; in the years 1967–71 exports declined to an average of 3,120 tonnes a year. The figure for the latter years covers a wide range, including a low of 1,250 tonnes in 1969. By 1971 the volume of exports had returned to earlier levels at 5,300 tonnes, and in 1972 7,000 tonnes were recorded. The distribution of Indian exports has changed somewhat: now relatively small amounts reach the European and North American markets. The bulk of the exports is sent to the countries of the Middle East and North Africa. Over the three seasons 1960–63, 16% of total Indian exports were destined for the UK and USA; over the three seasons 1969–71 the comparable figure was 6.5%. The Indian season usually consists of the 12 month period from April to March.

Nigeria built up its position as an exporter of dried ginger throughout the 1960's, although there was a downward fluctuation from this rising trend associated with the Civil War. Production now appears to have recovered. The dried ginger of Nigeria is derived from plants originating in Jamaica, although the environment has influenced significantly the properties of the spice obtained. The main form in which the ginger reaches the London market is that of Nigerian split; this is split longitudinally to speed drying. Split ginger has a lower market value than whole peeled ginger. The latter, when available, reaches a price comparable to that of Sierra Leone ginger; it is usually not as cleanly peeled as the Jamaican product.

The dried ginger of Nigeria has competed successfully with the Jamaican product, and as a material for grinding has been widely substituted for it. Over the years 1956–60 the average exports of dried ginger from Nigeria were 860 tonnes a year; for the years 1960–64 the average was 1,200 tonnes; for 1969–71 the figure recorded was 2,530 tonnes a year. A high point of 3,780 tonnes was reached in 1970, having risen from a low point of 1,240 tonnes in 1967. The major markets for Nigerian dried ginger are the UK, the USA and West Germany; this is a position which did not alter throughout the 1960's. In the years 1969–71, these three countries received 90% of Nigerian exports. Exports from Nigeria have made substantial gains in the markets of the three countries; in the UK the share has risen from 9% (1953–55) to 30% (1960–62) and further to 50% (1969–71); in the USA the comparable figures are 8%, 18% and 55%, while for West Germany in 1969–71 the share of Nigeria in the imports of dried ginger was 55%.

The dried ginger of Sierra Leone was for many years referred to in the trade as 'African'. It is considered a good all-purpose product. Since it is exported in the unpeeled form, it is not suitable for use in the grocery trade. The flavour is described as being somewhat camphoraceous, although more pungent than the dried ginger of Nigeria. Its high essential oil content ensures that it is in demand both for distillation and for the extraction of the oleoresin. The volume of exports fluctuates considerably; the average annual export was 990 tonnes in 1959–60, 590 tonnes in 1960–64, and 850 tonnes in 1967–71.

The main markets in recent years have been the UK, the USA and the Netherlands. In 1969–71 Sierra Leone dried ginger constituted 12% of UK imports, compared with 16% in 1960–62 and 54% in 1953–55. Comparable figures for the USA market, comparable figures are 10%, 17% and 28% of imports. This decline is not just a function of fluctuating exports from Sierra Leone, but is due to the growth of imports of dried ginger from other sources. The decline in export volume has been associated with a reduction in the acreage planted, following discontent among farmers both with the price received for the crop and with the marketing arrangements.

The four countries considered above have been the main suppliers of dried ginger on world markets. However, in the latter half of the 1960's a number of other countries have successfully penetrated the market, most notably the markets of the UK and the USA. Imports from countries other than India, Nigeria, Jamaica and Sierra Leone, as a proportion of total imports of dried ginger, were as follows:

	UK%	*USA%*
1953–55	4.7	14.0
1960–62	5.3	8.1
1969–71	22.0	23.5

The diversification in sources of supply to these markets was due to supply problems on the part of traditional exporters, allied to an overall increase in market size (see below), and a willingness on the part of a well-developed and cost conscious spice trade to consider new sources of production.

Fiji has expanded its exports of dried ginger from a level of 80 tonnes in 1961 to an average of 360 tonnes over the years 1965–67 and to an average of 920 tonnes over the years 1969–71. The main markets are the UK and the USA; in the latter it has become the second largest source. Initially its exports were to the US market where it began to make an impact in the years 1961–63. It was not until 1967 and the years following that substantial quantities were taken by the UK. The dried ginger is used for grinding.

A complication in assessing the exports of Fiji, however, is that no clear distinction is made between dried and fresh ginger. The production of ginger was initially established on the basis of supplying fresh ginger. In 1969–71 the two main markets, the UK and USA, had a combined average import volume of dried ginger totalling 620 tonnes a year, although it is known that fresh ginger from Fiji also entered the UK. This figure should be compared with an assumed average export figure of 920 tonnes a year (1969–71) for dried ginger. In the years 1969 and 1970, Hong Kong imported from Fiji green ginger at the rate of 370 tonnes and 285 tonnes respectively, compared with zero or small volumes before (Table 9 row 8). New Zealand has also been an importer of green ginger from Fiji, and since 1962 the volume has fluctuated between 30 and 60 tonnes a year.

For the UK, the two other major new sources in recent years have been Mauritius and Uganda. The fresh ginger of Mauritius has long been favoured in the UK; the dried ginger is now also imported and is used for grinding. Over the years 1969–71 the volume imported was an average of 170 tonnes a year. Imports of Ugandan dried ginger have been on average 180 tonnes a year over the same period.

Other sources of dried ginger have been Bangladesh, China, Taiwan, Australia and the East Caribbean States. Varied opinions have been expressed by the trade as to the quality of Australian dried ginger, but in general it is well-regarded and commands a price between that of the Jamaican and Sierra Leone products. Australia has only recently turned to the export of dried ginger; it has been a producer of well-regarded preserved ginger products for some time. The ginger used in the production of dried peeled whole ginger root comes from the late harvest of May and June. It is used mainly for the extraction of oleoresin and for the beverage industry. A second late harvest from July onwards makes available a ginger which is sold in the sliced, dried form for distillation and for grinding.

The dried ginger of China has gained in popularity in some European markets, particularly France. It is washed in a sulphur dioxide solution to give an almost white product, from which a pale coloured powder is obtained. This practice makes it unacceptable in some markets, such as the UK.

So far consideration of West Malaysia and Singapore as sources of supply has been omitted. A considerable trade in ginger can be attributed to these origins, a great deal of it between the two countries. The trade statistics for both give rise to some confusion as it is not entirely clear which type of ginger, fresh or dried, is referred to. Singapore handles ginger from sources other than West Malaysia, such as China, Taiwan and other countries. The export figures relating to Singapore are in fact re-exports, although it appears that a considerable amount of these would have been processed in Singapore. These re-exports go to a diverse group of markets, including Pakistan, countries in the Middle East, North and East Africa, and West Malaysia itself. The volume has fluctuated considerably between the years 1966 and 1972, with a low of 590 tonnes in 1969 and a high of 2,700 tonnes in 1972.

The statistics of West Malaysia do not distinguish between exports of fresh ginger and exports of dried ginger. However, by far the greatest proportion of exports goes to Singapore, and the bulk of this is recorded in Singapore's trade statistics as

imports of fresh ginger. Between 1965 and 1970 exports from West Malaysia rose from 800 tonnes to 2,600 tonnes and dipped to 2,000 tonnes in 1971. Over 90% of these exports can be assumed to consist of fresh ginger destined for Singapore.

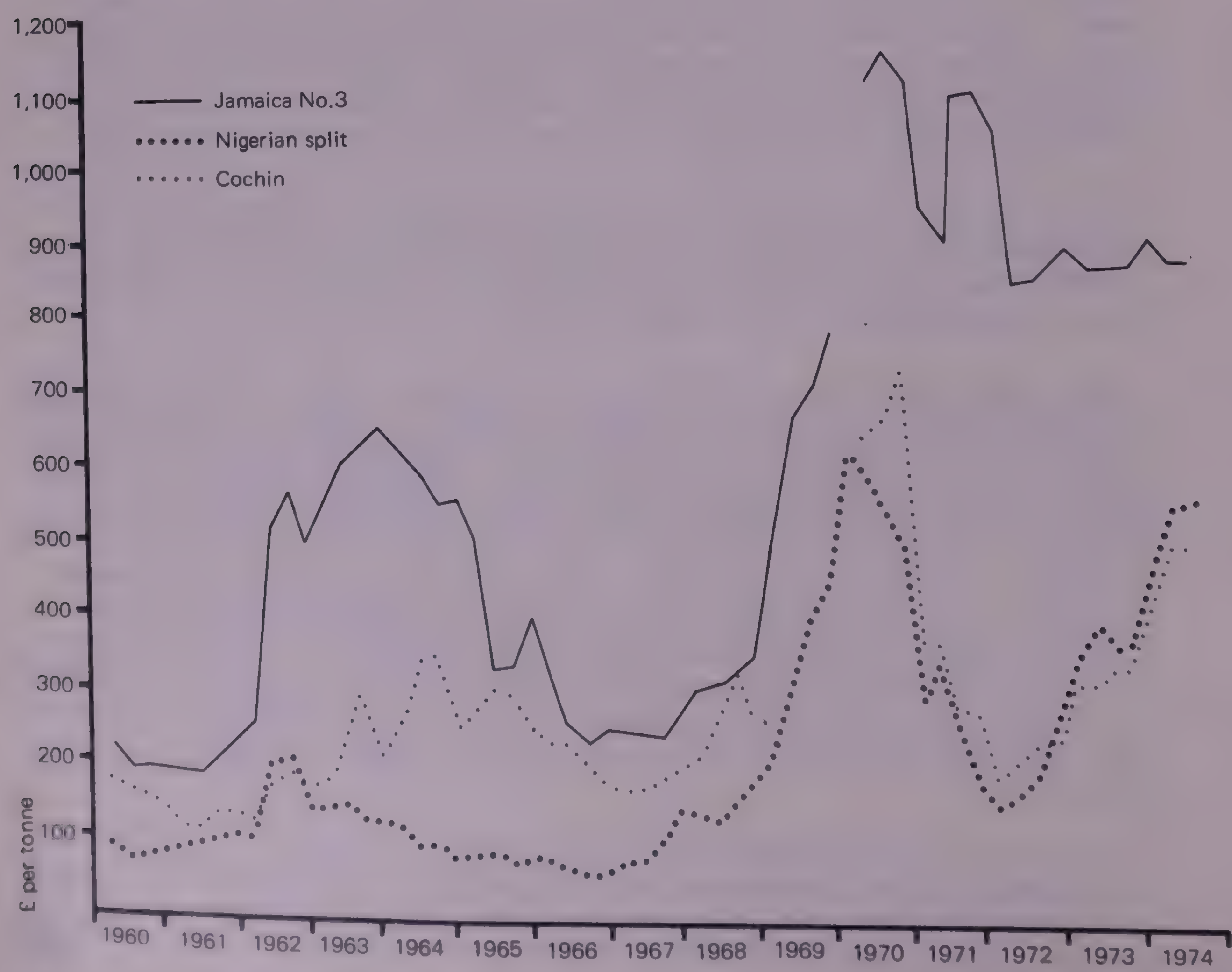
PRICES

Prices of dried ginger fluctuate over a wide range. The movement in prices for dried ginger from a few sources is shown in Figure 1. The figures are derived from Table 3 and show the quarterly average London cif spot price for Jamaican No 3, Nigerian Split and Cochin over the years 1960 to 1974 (Table 3 includes a quotation for the dried ginger from Sierra Leone).

There has been some contention among suppliers and some trade sources that over-production has been evident at times and has depressed price levels. Such an opinion was widely held in 1971. The dried ginger of India and Nigeria remain the dominant sources of supply and any shortfall in either product has a marked effect on general price levels in the market. The high price commanded by Jamaica No 3 can, to a large extent, be attributed to the high premium attached to this grade. However, the relatively high price levels of the early 1960's were a stimulus to its replacement in some uses by less highly regarded but less expensive dried gingers. The price has remained at its high level due to continuing problems of supply and sustained demand in the USA and for certain specialised uses.

The price of dried ginger from the established sources rose to a high level after 1972, a trend which continued into 1974. This rapid rise may now have reached a high point and some tailing off might be expected in the future. The upward trend is a reflection of supply problems with the Indian crop in 1973 and Nigeria's

Figure 1
Prices for dried ginger (London, cif spot), quarterly average.



reduced output in both 1971 and 1972. The rise in price may also be associated with the general rise in commodity price levels experienced in recent years.

In looking at the relationship between the price of dried ginger and the volume of imports or the volume of exports for particular countries, no strong correlation has been identified. The yearly fluctuations in price and volume of trade may be determined partly by the holding of stocks and speculative activity which can weaken the relationship between movement in price and movements in the volume of trade.

MARKETS

The largest markets for dried ginger remain those of the UK and the USA. The problem in assessing the markets for many countries is that a clear distinction is not made in trade returns between the various forms of ginger. Hence the statistics should be treated with caution. The problem is most acute for the countries of the Middle East and North Africa. With respect to the European and North American markets, trade sources indicate that the statistics refer mainly to dried ginger.

Table 4 summarises the levels of imports for the main markets. However, some important countries have been excluded because of the confusion arising from the statistical information relating to them. The situation of West Malaysia and Singapore has been outlined above, in particular the lack of categories dividing the trade returns into imports of fresh ginger and dried ginger. Between the years 1965 and 1970 imports of 'dried' ginger into West Malaysia recorded in the trade returns declined from 620 tonnes a year to 240 tonnes a year, although with fluctuations around this trend. It is not possible to tell whether any of this quantity was fresh ginger because of the lack of division mentioned above. Imports recorded in the trade returns of Singapore are usually considered to relate mainly to fresh ginger. This is used in processing and as re-exports. These imports into Singapore are at high levels, the average of 1969–71 being 3,230 tonnes a year. This compares with an average of 1,700 tonnes a year in 1957–61. The last figure is an estimate derived from the trade returns of the Federation of Malaya, in which Singapore was united with West Malaysia The other important exclusions are Saudi Arabia and South Yemen. There seems to be a reversal in the position of these countries, with the former becoming of greater importance after 1966/67. This may indicate a decline in the entrepot trade of Aden. However, from an average level of 2,800 tonnes a year in 1957–61 the combined imports of Saudi Arabia and South Yemen declined to an average of 1,700 tonnes a year in 1967–69, but in 1971 were at a level of 2,900 tonnes. The market here and in other Middle Eastern countries appears to be constant.

Table 5 gives a detailed breakdown of imports by source for the UK and the USA respectively. For the former the important change in the structure of imports is the rise in importance of Nigeria and the decline of Jamaica and Sierra Leone. However, in the latter half of the 1960's other countries made their mark. These were Mauritius, Fiji, Uganda and lately Australia and the East Caribbean States (see the table on p.21). The rise of Nigeria and the decline of Jamaica and Sierra Leone is also exhibited in the market of the USA. Imports of the Cochin grade have also declined in comparison with the level of the early 1960's. The other countries which have made an impression in this market have been Fiji (including some other Pacific Islands) and, latterly, if only to a small extent, Australia.

Turning now to total imports of the UK and USA, a comparison of the levels for 1953–55 and 1960–62 with the most recent figures available indicates that there has been on balance a growth in imports. The statistics for the UK show a movement in terms of annual average volume of imports from 1,580 tonnes (1953–55) to 1,360 tonnes (1960–62) and to 2,300 tonnes in 1969–71. The statistics for

the USA show a movement in terms of annual average volume of imports from 1,290 tonnes (1953–55) to 1,830 tonnes (1960–62) and to 2,220 tonnes (1969–71). The figures for the USA indicate a steadier rate of increase. However, in neither case is any really marked increase in imports foreseen. Of the other major markets in the developed countries, the most promising seems to be that of West Germany, although since 1968/69 import volume has held constant. The Netherlands, Canada and Japan are other markets which have experienced increases in imports.

CONCLUSION

Trade opinions as to future prospects for the market for dried ginger are varied. Increasing concern has been expressed both by trade sources and exporting interests with regard to evident over-production. This over-production is seen as a consequence of the stimulus provided by the high price levels reached after crop shortfalls in the main producing countries, and concern was particularly intense in the years 1971 and 1972. An assessment of this issue is complicated by the interaction of short-term fluctuations and under-lying trends. At present, however, prices have been moving upwards following the sharp decline from the levels reached in 1969 and 1970. Shortfalls in the supplies of the two major exporting countries, India and Nigeria, would appear to be the cause of this rise. Assuming exports from these two sources rise again over the next year or two, a further sharp decline in price levels may be expected.

Opinion has also been expressed in the trade that there could be room for new suppliers. The experience of the 1960's bears this out, with the expansion of Nigerian supplies and the establishment of new sources such as Fiji. However, with the successful expansion and establishment of these suppliers, the position for new suppliers in the 1970's might not be so promising. It remains true that while brokers and grinders are ready to co-operate in assessing samples from new sources, users do have established preferences with respect to sources and the associated characteristics and quality of dried ginger. In order to induce users to consider and to take up a new producer's supply, dried ginger of good quality at a very reasonable price would have to be offered.

Nevertheless, of the products considered in this report dried ginger probably offers the most scope for new entrants. There has been an increase in the markets both of the UK and of the USA, probably associated with the increasing share of the processed and prepared foods sector in the food market. A number of European countries, such as West Germany and the Netherlands, may be promising markets, as are Canada and Japan. The continuation of such trends, however, cannot be assured; over the last two or three years there has been a levelling off in expansion. The effect of the present energy crisis on consumption patterns and on growth in personal incomes is not easily predictable. Of other major markets, in the Middle East and North Africa, consumption has not grown greatly. If the main use in these countries continues to be in domestic food preparations, consumption cannot be expected to grow at a rate faster than population growth.

Preserved ginger

The products traded as preserved ginger are made mainly from the unpeeled rhizome preserved in syrup.

Crystallised ginger is obtained from preserved ginger by further processing, which is undertaken both in the exporting countries and by firms in the importing countries. Fresh or green ginger may also be pickled in salt and vinegar for subsequent use in preserving.

The main industrial uses for preserved ginger are in the confectionery industry, particularly in the manufacture of chocolate, the bakery industry and in jam, marmalade, sauce, pickle and chutney manufacture. The product is also sold in jars through the retail trade and used by processors to make crystallised ginger. This also has a retail outlet, and is used in addition in the bakery and confectionery trades. All uses of preserved ginger are confined to the food trade.

SOURCES AND SUPPLIES

During the last decade the main development has been the firm establishment of the Australian industry which has had a notable success in entering the UK and other markets. This has been at the expense of Hong Kong and China: exports from these countries have stagnated or declined.

In considering the trade in preserved ginger, however, it is necessary to treat the statistical information on exports and imports with caution. The problem is due to the variation in the ratio of ginger to syrup in the various packs, according to destination. One of the reasons claimed for the success of the Australian products is that the syrup content has been satisfactorily reduced. Thus the export of an equivalent weight of ginger which is preserved in syrup would be recorded as being a lower export volume in the case of Australia than for Hong Kong. This fact should be borne in mind when the relative importance of the two industries on the basis of export volume is considered.

A further problem with trade statistics is that not all importing countries have a separate category for preserved ginger products, including the item in the import figures for the other types of ginger. For instance, after 1964 one of the markets, the USA, ceased to record preserved ginger products separately. The breakdown of statistics of the exporting countries by country of destination is an alternative means of estimating these figures.

The major exporting countries are Hong Kong, China and Australia. The first processes the green ginger imported from South East Asia and China; the other two rely on the domestic production of green ginger. Hong Kong has long been dominant in the trade. China has been the other major source although no detailed export figures are available and it is understood that production and export from China is erratic. Australia has become a major force only since the

mid-1960's. Comparison of market shares between these countries is complicated by the issues raised above with respect to the statistical information. However, a comparison can be made between trends in export volume.

The exports and re-exports of Hong Kong and Australia are summarised in Tables 6, 7 and 8. For 1953–55 the annual average volume of exports of ginger preserved in syrup from Hong Kong was 3,455 tonnes; in the years 1960–62 it had not advanced beyond an average of 3,670 tonnes a year. After this period there was considerable fluctuation between 2,000 tonnes and 5,000 tonnes a year, although in 1968–70 exports declined to an average of 2,430 tonnes a year and in 1972 2,260 tonnes were exported.

The volume of Australian exports has shown a consistent and rapid upward movement from 84 tonnes in 1962–63 to 646 tonnes in 1969–70 and a further rise to 880 tonnes in 1971–72. Bearing in mind the points raised above as to the ratio of ginger to syrup, this latter volume is in fact closer to that of Hong Kong than it appears, if we take account of the weight of actual ginger rather than the gross weight including syrup which is recorded.

The information for China has been taken from the import statistics of the UK, the dominant market for preserved gingers. These imports are detailed in Table 11; the volume fluctuates, although since 1965 it has been at a considerably higher level than previously. These imports reached a peak of 795 tonnes in 1966 and 905 tonnes in 1967; since then they have slipped back somewhat to around half that quantity.

The ginger used for processing into preserved products is harvested earlier than that destined for dried ginger. It is then more succulent, less pungent and less fibrous. The main sources of imports of green ginger into Hong Kong have been the Canton region of China and Taiwan. The latter has also exported substantial quantities of ginger in temporary preservative to Hong Kong (see Tables 9 and 10). Since the early 1960's Taiwan has been the more important source. Its substantial increase in production and export in comparison with the levels of the early 1950's seems to have been made possible by the existence of the market for green ginger in Hong Kong.

Other sources used by Hong Kong in recent years have been the Philippines and Thailand. In the 1950's Japan was important, but Hong Kong no longer receives supplies from this country. The total quantity imported into Hong Kong was an average of 6,040 tonnes a year in 1953–55; by 1960–62 it had reached an average of 8,035 tonnes a year. Since then imports of green ginger into Hong Kong have fluctuated between 5,000 tonnes and 7,000 tonnes a year; for the period 1969–72 imports averaged 6,710 tonnes a year.

The success of the Australian movement into the market may be put down to a number of factors. It was made possible partly by some discontent with existing suppliers. This has been suggested particularly in relation to China, from which supplies had been inconsistent in quantity and variable in quality. The same variability had been evident in relation to the products of Hong Kong which come from a number of small suppliers. Within Hong Kong there had been some attempts at control of production and price levels through the operation of a syndicate.

The Australian effort was marked by an extensive market research survey. The output is concentrated in one large concern linked direct with the growers of the ginger through a co-operative arrangement. In order to make mechanised processing possible, heavy investment in capital equipment was undertaken. By this method a more consistent product and improved quality was obtained.

The research effort indicated that the major customers were interested in the ginger flavour, and not the heat associated with ginger products. The production

of a ginger with milder flavour gave an advantage over that of China which had been noted for the degree of heat in the flavour. Greater control over production of green ginger demanded an investigation into the time of harvesting. It was found that the succulent ginger required in preserving was obtainable by an early harvest before the crop had matured. By taking an early crop around late February or early March, a relatively fibre-free ginger is obtainable at the sacrifice of yields. The yields are lower than for the two late crops which are reserved for dried ginger production. The time of planting is between September and mid-October. The crop obtained from the early harvest has a lower ginger oil content and so gives the valued milder flavour. The standardised and controlled processing also ensures that little, if any, foreign matter is present in the finished product.

With improved quality control and harvesting arrangements, it was possible to meet the specific requirements of industrial customers. The Australian product is sold at a premium price, the advantages of consistency, milder flavour and freedom from fibre being in its favour. As the product is made to the specification of the large industrial user, it is not necessary that expensive refinement and modification be undertaken. The standardisation of production has facilitated a reduction in the ratio of syrup to ginger which has led to reduced costs of transport, handling and storage.

QUALITY AND PRICES

Preserved ginger has been categorised on the basis of a number of qualities; those recognised by the London trade are as follows: *Stem*, which is the finest ginger made from projections of rhizome; *Cargo*, which is from the remainder and which is divided into the four sub-grades of *Bold, Medium, Small Medium,* and *Tails and Pieces.* A quality known as shavings is made from the trimmings.

With the advent of the Australian products these categories have lost much of their significance. A greater proportion of the preserved ginger in syrup is now made to the specific requirements of the large industrial users.

There are a variety of cuts produced by the Australian industry, depending on end-use; these cuts are characterised by a different ginger/syrup composition, ranging from a 60:40 ratio of ginger to syrup, to an 80:20 ratio of ginger to syrup. In the trade the cuts are known as sliced, diced and crystallised. The Australian products are exported in steel drums of 500 to 600 lb, depending on the ginger/syrup composition. The steel containers are considered superior to the wooden casks used in the export of preserved ginger from China and Hong Kong.

The prices for Stem and Bold qualities are no long quoted in the Public Ledger. Prices have varied for these within the range of £75 to £150 a tonne (cif) in recent years. The price of the Australian products is dependent on type of product and quality; at the lower end, the price has been around £150 a tonne, and up to £500 a tonne for the better qualities. No extensive price series for preserved ginger products is available.

MARKETS

The major market for preserved ginger is the UK. The main sources of supply for this market are Hong Kong, China and Australia. The relative position between these has been discussed above, as have the factors which affected the switch to the Australian products. For the UK and other importing countries there is no recorded breakdown by type of preserved ginger product, although it is evident from export statistics that by far the most important are the gingers preserved in syrup.

In looking at total imports into the UK (Table 11) it is evident that demand is stagnating, and even declining. This is certainly the case if we consider the

position in terms of consumption per head. In the years 1953–55 the average import was 2,260 tonnes a year; in 1960–62 this figure was 2,735 tonnes; and for the years 1969–72, 1,820 tonnes.

The only other major importing country is the Netherlands. A comparison between the import statistics (Table 11) and the export statistics of Hong Kong (Table 6 row 3) indicates a wide discrepancy after 1967. Taking the latter figures it is evident that imports are considerably higher than in the years 1953–55 (average 570 tonnes a year) and 1960–62 (average 625 tonnes a year) although there has been a levelling off since the peak of 1,810 tonnes in 1965. The discrepancy may be accounted for by re-exports from the Netherlands to other EEC members.

Australia was a sizeable market for Hong Kong's product, but with the establishment of its own industry there has been a drastic curtailment of imports since 1964–65. Other markets of note are those in the Federal Republic of Germany, Canada, South Africa and the USA. However, in none of these has there been a dramatic and consistent upward movement in imports other than in the German Federal Republic.

CONCLUSION

The market prospects for preserved ginger are not encouraging for any potential new supplier. The market has shown no significant increase since the 1950's in the main market, which is the UK. There has been some upward movement in other markets, in particular the Netherlands, but this has levelled off somewhat after the initial acceleration.

The success of Australian exports has been the result of an extensive research effort and capital investment, as well as control of the whole process from the growing of ginger to the marketing of the finished product through agents dealing direct with the exporting concern. It is unlikely that this could be repeated in many developing countries which might be prospective exporters.

A notable feature of the trade, however, has been the growth in the export of green ginger from Taiwan to Hong Kong. For a number of countries in Eastern Asia there might be potential for supplying Hong Kong with green ginger to be used in its preserving industry. Against this possibility has to be set the relative decline in the production and export of preserved ginger from Hong Kong, which has partially been due to problems in the supply of green ginger from China. It is possible that diversification within the Hong Kong economy has opened up more profitable production and trade opportunities for those who were engaged in the preserved ginger trade.

Fresh ginger

Fresh ginger is the untreated rhizome. It enters international trade for two purposes: firstly, to be used for culinary purposes as green ginger, and secondly, as a raw material for further processing. For the first use, fresh (or green) ginger is grown largely for consumption in the countries of production and little enters international trade. Ginger may also be salted before export to be used in production of preserved ginger.

SOURCES AND SUPPLIES

As many countries do not have a separate category in the trade returns, there is little statistical data relating to trade in fresh ginger. Table 9 shows the import of fresh and salted ginger into Hong Kong; this has been discussed above. Hong Kong also re-exports fresh and salted ginger, although the volume of this trade fluctuates widely and since 1966 has been less than 50 tonnes a year. The main destinations for these products have been the UK, Peninsular Malaysia and Singapore, although these three have not always been important in the same year. The cif value of the imports into Hong Kong has varied according to source. The ginger from China has fluctuated between £22 and £44 a tonne; that from Taiwan has fluctuated between £21 and £50 a tonne. In the 1950's a higher price was received for the green ginger of China than for that of Taiwan. In the 1960's there has been a lessening in the differential and in some years ginger from Taiwan has been more expensive. The average fob value of re-exports from Hong Kong has been considerably higher than that of imports. In recent years it has been three to five times that of imports (cif value); the range has been between £45 and £230 a tonne.

MARKETS

Western Malaysia and Singapore both import considerable quantities of fresh ginger. In the case of the latter, the bulk of these come from Peninsular Malaysia and have varied between 1,500 tonnes and 3,600 tonnes a year (1966–72). Besides Peninsular Malaysia the other sources have been China, Taiwan and Thailand. Aspects of this trade have been discused above. Imports into Peninsular Malaysia fluctuated between 1,500 tonnes and 2,500 tonnes a year until 1966. From that year onward there has been a considerable decline to a level of less than 1,000 tonnes a year; in 1972 imports were as low as 380 tonnes. For Singapore, the average cif value has fluctuated between £40 and £105 a tonne (1966–70); for Peninsular Malaysia the value has varied between £25 and £55 a tonne (1960–70).

Little fresh ginger is imported into the UK. Trade sources put the figure at around 50 tonnes a year. The market is considered to be static with little change during the last decade. The main suppliers are Mauritius, Fiji and Singapore, although some fresh ginger has been received from West Africa and Hong Kong as

well. The fresh ginger is either sold direct through the retail trade, largely to the immigrant market in the UK, or is further processed. The amount imported varies from year to year; in some years it may be over 100 tonnes, a proportion of which is likely to be used over a period of more than one year.

Fresh ginger should reach its destination with the minimum of deterioration. For this reason, the fresh ginger of Mauritius is favoured, as it is considered to have superior keeping qualities. In some instances, fresh ginger is flown in by air to save time in transit and it is then considerably more expensive (three to four times) than other fresh gingers. In the UK market there are wide seasonal fluctuations in the prices of fresh ginger. The price of fresh ginger brought into the UK by ship has fluctuated over a range of £50 to £150 a tonne in recent years. The price received is dependent on the time of year and the source of supply.

CONCLUSION

The lack of any major expansion in the UK market during the last decade has resulted in producers of fresh ginger seeking other outlets for the crop. In particular, Mauritius, Fiji and Uganda have become important sources of dried ginger. More recently the East Caribbean States have been switching to the export of the dried product, partly as a response to the problems experienced with the disposal, as fresh ginger, of an increasing ginger crop.

Some of the countries of Asia might provide a limited market. At present these are self-sufficient, but population pressure and production shortcomings might give rise to a seasonal and fluctuating demand for imported fresh ginger. As well as a fluctuation in the volume of imports, the price offered is also likely to vary.

In considering the production of fresh ginger the points raised above in the section on preserved ginger concerning the Hong Kong market should be borne in mind. In doing so the different nature of the ginger used in domestic cooking and as a raw material for preserving should be considered carefully. The prospects for fresh ginger appear to be limited, particularly in respect of the retail trade outlets for domestic cooking in the UK and the other West European and North American markets.

Appendix I

Trade statistics

Table 1

Exports of dried ginger by country

tonnes

		1953–55 (1)	1960–62 (1)	1963–65 (1)	1966	1967	1968	1969	1970	1971	1972
1	India	2,700	6,150	4,160	4,420	4,340	2,230	1,250	2,240	5,280	7,010
2	Nigeria	405	1,275	2,395	2,845	1,240	1,960	3,240	3,780	2,350	2,090
3	Sierra Leone	1,610	520	710	850	930	1,560	670	440	600	500
4	Jamaica	1,185	640	700	835	725	460	280	305	360	350
5	Singapore (2)	...	...	...	810	1,050	740	590	1,380	720	2,720
6	Fiji	...	...	...	...	295	...	420	1,645	705	...

Source: trade returns

Footnotes: (1) annual average
(2) re-exports
... not available

Table 2

Exports of dried ginger from India, Nigeria and Singapore by destination

tonnes

		India 1969–71 (1)	Nigeria 1969–71 (1)	Singapore 1969–71 (1)
1	UK	30	1,200	–
2	USA	160	1,000	–
3	Federal Republic of Germany	–	580	–
4	Netherlands	–	80	–
5	Canada	25	–	–
6	Kuwait	170	–	–
7	Saudi Arabia and South Yemen	1,090	–	120
8	Other countries	1,445	2,200	780

Source: trade returns

Footnotes: (1) annual average – nil or negligible

Table 3

Average quarterly prices, dried ginger (London cif spot)

£ per tonne

		Jamaica no 3	Nigerian split	Cochin	Sierra Leone
a		b	c	d	e
1960	I	225	80	180	150
	II	190	75	160	145
	III	190	*	160	220
	IV	190	*	140	210
1961	I	190	95	120	140
	II	190	100	120	150
	III	220	*	140	200
	IV	*	120	135	220
1962	I	340	120	120	*
	II	525	200	185	390
	III	580	210	200	410
	IV	490	140	160	410
1963	I	570	150	180	305
	II	620	155	240	335
	III	—	140	300	265
	IV	660	130	230	265
1964	I	630	115	280	235
	II	605	100	335	285
	III	550	90	360	300
	IV	560	85	265	310
1965	I	500	90	280	295
	II	325	90	305	220
	III	345	85	295	215
	IV	405	90	250	210
1966	I	330	85	230	220
	II	260	75	230	220
	III	235	65	210	210
	IV	250	70	165	205
1967	I	245	75	155	210
	II	240	80	170	150
	III	240	100	200	155
	IV	270	140	215	170
1968	I	310	140	230	185
	II	320	130	285	140
	III	330	150	330	160
	IV	355	170	270	195
1969	I	460	200	255	135
	II	670	295	*	...
	III	700	405	550	...
	IV	770	435	*	...
1970	I	*	630	640	...
	II	1,110	580	660	...
	III	1,160	530	730	...
	IV	1,160	495	540	...
1971	I	950	290	370	...
	II	880	360	365	...
	III	1,100	255	300	...
	IV	1,100	150	290	...
1972	I	890	155	210	300
	II	840	145	210	250
	III	850	190	235	240
	IV	855	220	235	*
1973	I	905	340	310	425
	II	870	390	310	460
	III	870	360	315	460
	IV	870	365	315	460
1974	I	910	470	440	665
	II	880	550	500	665
	III	880	560	500	*

Source: Public Ledger

Footnotes: * not quoted
... not available

Table 4

Imports of dried ginger by country

tonnes

		1953–55[1]	1960–62[1]	1963–65[1]	1966	1967	1968	1969	1970	1971	1972
1	UK	1,580	1,360	2,260	2,220	2,040	1,550	1,980	3,020	2,180	1,480
2	USA[2]	1,290	1,830	1,620	2,370	1,680	1,630	2,250	2,360	2,050	2,680
3	Federal Rep. of Germany	–	–	–	380	450	710	550	670	670	660
4	France	–	30	60	50	30	20	60	60	70	90
5	Canada	–	190	300	240	280	250	340	360	320	340
6	Japan	–	–	–	420	300	400	430	420	610	–
7	Netherlands	–	–	–	160	160	210	250	240	270	290
8	Morocco	–	260	250	250	330	400	180	270	500	–
9	Iran	–	–	–	210	310	–	–	–	310	–
10	Sri Lanka	–	150	110	150	80	60	70	–	–	–
11	New Zealand	–	60	80	80	80	120	60	90	60	–

Source: trade returns

Footnotes: [1] annual average
[2] after 1965 includes quantity of preserved ginger
– not available or negligible

Table 5

Source of imports of dried ginger into the UK and USA (annual average)

tonnes

		UK			USA[1]		
		1953–55	1960–62	1969–71	1953–55	1969–62	1969–71
	a	b	c	d	e	f	g
1	Jamaica	490	250	100	540	370	170
2	Sierra Leone	850	210	270	360	320	210
3	Nigeria	140	400	1,200	110	330	1,210
4	India	30	430	40	110	670	120
5	Other	70	70	750	180	150	500
6	(Mauritius)	–	–	(280)	–	–	–
7	(Uganda)	–	–	(150)	–	–	–
8	(Fiji)	–	–	(240)	–	–	(380)
	Total	*1,580*	*1,360*	*2,360*	*1,290*	*1,830*	*2,220*

Source: trade returns

Footnotes: [1] see footnote [2] of Table 4
– negligible

Table 6

Exports of preserved ginger from Hong Kong, by destination

tonnes

		1953–55(1)	1960–62(1)	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	A. Preserved ginger in syrup												
1	UK	2,170	2,380	1,090	1,600	2,290	1,815	1,390	1,000	1,345	705	445	970
2	Federal Republic of Germany	90	115	80	165	360	320	320	290	85	55	50	130
3	Netherlands	570	625	445	1,055	1,810	1,400	850	1,275	960	780	1,030	970
4	USA	65	40	10	30	60	40	45	50	40	50	40	55
5	Canada	50	100	90	90	105	70	65	30	30	45	45	15
6	Australia	330	240	170	100	50	25	40	45	30	40	35	30
7	South Africa	60	80	105	105	110	115	160	130	65	40	50	30
8	Other countries	110	90	50	75	75	70	70	80	65	60	60	60
9	*Total*	*3,445*(2)	*3,670*	*2,040*	*3,220*	*4,860*	*3,855*	*2,940*	*2,900*	*2,620*	*1,775*	*1,755*	*2,260*
	B. Preserved, dry ginger												
10	UK	–	62	335	116	11	10	13	12	8	8	7	7
11	USA	–	39	49	19	14	11	13	9	10	9	2	4
12	Other countries	–	67	99	65	19	11	19	4	9	8	2	2
13	*Total*	*218*(2)	*168*	*483*	*200*	*44*	*32*	*45*	*25*	*27*	*25*	*11*	*13*
	C. Crystallised ginger(3)												
14	*Total*	–	*12*	*6*	*11*	*18*	*17*	*34*	*35*	*45*	*40*	*38*	*45*

Source: Hong Kong Trade Statistics (Department of Commerce)

Footnotes: (1) annual average
(2) includes re-exports
(3) not shown separately before 1959

Table 7

Re-exports of preserved ginger from Hong Kong

tonnes

		1960–62[1]	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	A. Preserved ginger in syrup											
1	UK	180	430	370	–	5	20	1	740	160	105	50
2	Netherlands	435	355	290	–	40	–	–	240	405	210	40
3	Federal Republic of Germany	120	180	135	–	10	20	–	210	200	230	105
4	Other countries	40	45	30	8	10	25	7	25	25	20	10
5	*Total*	*775*	*1,010*	*825*	*8*	*65*	*65*	*8*	*1,215*	*790*	*565*	*205*
	B. Preserved, dry ginger											
6	*Total*	*75*	*122*	*24*	*28*	*13*	*7*	–	*38*	*63*	*23*	*70*

Source: Hong Kong Trade Statistics (Department of Commerce)

Footnote: [1] annual average
– nil or negligible

Table 8

Exports and re-exports from Australia, by destination: fresh and preserved ginger

tonnes

		1959/60–1961/62[1]	1962–63	1963–64	1964–65	1965–66	1966–67	1967–68	1968–69	1969–70	1970–71	1971–72
1	USA	49	49	94	–	–	–	12	15	23	119	70
2	UK	–	–	–	68	62	62	195	313	355	451	567
3	New Zealand	36	30	–	46	59	70	66	31	118	120	103
4	Other countries	26	2	30	7	12	24	40	79	197[2]	215	139
5	*Total*	*111*	*81*	*124*	*122*	*133*	*156*	*303*	*438*	*693*	*905*	*879*

Source: Overseas Trade
(Bureau of Census and Statistics)

Footnotes: (1) annual average
(2) of which: Netherlands – 68 tonnes
South Africa – 58 tonnes
Canada – 21 tonnes

– nil or negligible

Table 9

Imports into Hong Kong of fresh or salted ginger

tonnes

		1953–55[1]	1960–62[1]	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	China	4,125	1,165	800	3,860	4,570	3,795	805	795	2,475	1,370	2,000	1,340
2	Taiwan	750	5,060	5,610	3,120	1,980	2,180	3,010	1,575	3,720	5,220	3,765	4,680
3	Japan	960	720	30	120	15	10	–	–	–	–	–	–
4	Macao	205	25	–	–	–	–	–	–	–	–	–	–
5	Philippines	–	720	110	10	–	–	1,330	2,350	200	10	145	1,000
6	Thailand	–	365	45	–	–	–	10	90	5	–	–	100
7	South Vietnam	–	200	–	–	–	–	–	–	–	–	–	–
8	Fiji	–	–	–	–	–	–	–	25	370	285	–	–
9	Other countries	–	50	25	–	–	–	65	295	50	10	10	170
10	*Total*	*6,040*	*8,305*	*6,620*	*7,110*	*6,565*	*5,985*	*5,220*	*5,130*	*6,820*	*6,895*	*5,920*	*7,290*

Source: Hong Kong Trade Statistics
(Department of Commerce and Industry)

Footnotes: (1) annual average
– nil or negligible

Table 10

Imports into Hong Kong of ginger preserved in syrup, preserved dry, and in temporary preservative

tonnes

		1960–62[1]	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	A. Ginger, preserved in syrup											
1	China	77	17	52	70	150	33	13	78	73	29	104
2	Taiwan	68	17	157	30	1	–	–	4	17	18	37
3	Other countries	8	1	19	13	9	10	30	15	10	10	79
4	*Total*	*153*	*35*	*228*	*113*	*160*	*43*	*43*	*97*	*100*	*57*	*220*
	B. Ginger, preserved dry											
5	China	151	53	99	145	125	41	13	32	52	29	15
6	Taiwan	38	75	170	244	5	1	–	–	–	1	1
7	Other countries	8	20	4	26	4	1	8	1	5	5	1
8	*Total*	*197*	*148*	*273*	*415*	*134*	*43*	*21*	*33*	*57*	*35*	*17*
	C. Ginger, in temporary preservative[2]											
9	Taiwan	–	–	559	301	245	372	1,691	689	267	94	200
10	Other countries	–	–	48	30	–	–	75	85	276	–	108
11	*Total*	–	–	*607*	*331*	*245*	*372*	*1,766*	*774*	*543*	*94*	*308*

Source: Hong Kong Trade Statistics (Department of Commerce and Industry)

Footnotes: (1) annual average
(2) not recorded separately before 1964
– nil or negligible

Table 11

Imports of preserved ginger into the UK, Netherlands, Australia and the Federal Republic of Germany

tonnes

		1953–55[1]	1960–62[1]	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	UK												
1	*Total*	*2,260*	*2,735*	*1,950*	*2,190*	*2,710*	*2,765*	*2,420*	*1,825*	*2,540*	*2,120*	*1,195*	*1,935*
2	(China)	–	85	15	160	345	795	905	560	235	410	275	320
3	(Hong Kong)	2,090	2,625	1,920	2,090	2,275	1,875	1,420	980	2,085	1,135	500	930
4	(Australia)	–	–	–	–	70	75	80	280	210	500	390	675
5	(Other countries)	170	25	45	40	30	20	15	5	10	75	30	10
6	Netherlands	...	1,010	930	1,360	1,765	90	85	90	80	40	55	80
7	Australia[2]	280	380	410	380	200	120	130	100	90	75	40	40
8	Fed. Rep. of Germany	...	...	...	...	...	...	...	...	500	400	410	400

Source: Trade returns

Footnotes: (1) annual average
(2) for years 1959/60 to 1971/72
... not available
– nil or negligible

Appendix II

Standards for dried ginger

In the UK no standard has been put forward by the food trade. However, most importers taking dried ginger use the following British Standard:

Ginger (whole, in pieces and unground), BS 4593:1970

Moisture, by mass	not more than 12%
Total ash, on dry basis	
(i) unbleached	not more than 8%
(ii) bleached	not more than 12%
Calcium (as CaO), on dry basis	
(i) unbleached	not more than 1.1%
(ii) bleached	not more than 2.5%
Volatile oil, on dry basis	not less than 100 millilitres per 100g

Ground ginger

In addition to the above, the following requirements are specified:

Water-soluble ash, by mass on dry basis	not less than 1.9%
Acid-insoluble ash, by mass on dry basis	not more than 2.3%
Alcohol-soluble extract, by mass on dry basis	not less than 5.1%
Cold water soluble extract, by mass on dry basis	not less than 11.4%

It is estimated that over 90% of the ginger entering the UK meets the above requirements. Ginger which is of substandard quality may be ground down and blended to satisfy the specifications.

Apart from the official standard, there is available in the UK an older analytical standard in the *British Pharmacopoeia,* which is used for pharmaceutical preparations:—

Ash, by mass on dry basis	not more than 6%
Water-soluble ash, by mass on dry basis	not less than 1.7%
Water-soluble extractive, by mass on dry basis	not less than 10.7%
Alcohol-soluble extractive, by mass on dry basis	not less than 4.5%

The standard is applicable to unbleached Jamaican dried ginger.

The American Spice Trade Association has given a standard for imports into the USA as follows:—

Starch	not less than 42%
Crude fibre	not more than 8%
Lime (CaO)	not more than 1%
Cold-water extract	not less than 12%

Total ash	not more than 7%
Ash insoluble in hydrochloric acid	not more than 12%
Ash soluble in cold water	not less than 2%

The above is applicable to unbleached ginger from sources other than Jamaica. For ginger from Jamaica the cold water extract must not be less than 15%. A general specification is added to the effect that spices should not be adulterated and should be free of filthy, putrid or decomposed substances, in whole or in part, and that the maximum percentage of permissible extraneous matter is 0.5%.

Generally, imports of dried ginger have to comply with the Food and Drugs Acts of the importing country; these requirements vary from country to country.

Appendix III

Tariffs and import taxes in selected countries

All duties quoted below are, unless otherwise stated, *ad valorem* and based upon the cif value of the goods. The duties given are as at 1 January 1975.

UNITED STATES OF AMERICA

Ginger, unground: duty free.

Ginger, ground: 1¢ per lb.

CANADA

There are four rates as follows:

British Preferential Tariff (BPT), applicable to imports from UK and the Commonwealth.

Most-favoured Nation Tariff (MNT).

General Tariff (GT).

General Preferential Tariff (GPT), applicable to certain developing countries.

All duties are based on the fob value of imports.

	BPT	MNT	GT	GPT
Ginger, unground	Free	5%	12½%	Free
Ginger, ground	5%	7½%	10%	5%

JAPAN	General/GATT	Preferential (for certain developing countries)
Ginger, unground	5%	Free
Ginger, ground	5%	Free

NEW ZEALAND

Ginger, unground green: duty free

Ginger, unground dry: 7½% (Australia and Canada free; certain developing countries and Commonwealth other than UK and Republic of Ireland, free from 1976).

Ginger, ground: 20% (Australia free, Canada 12%; Commonwealth other than UK and Republic of Ireland, 12½% from 1976).

Ginger, ground packed for retail sale: 37% falling to 32½% in 1977; (Australia and Canada 22½% in 1975; Commonwealth other than UK and Republic of Ireland 22½% from 1976).

EUROPEAN ECONOMIC COMMUNITY

Since 1 July 1968 a Common Customs Tariff (CCT) has been applied to imports from all countries outside the EEC. The new member states of the UK, Denmark and the Republic of Ireland are moving to full harmonisation with the CCT by 1977.

Ginger, unground or ground: duty free.

Apart from import duties, imports are also subject to additional taxes from which (unlike customs duties) members of the EEC are not exempted. The most common of these is the tax levied on value added at the following rates:

FRANCE

Added value tax: 7%

NETHERLANDS

Added value tax: 16%

FEDERAL REPUBLIC OF GERMANY

Import turnover tax: 5.5%

These are levied on the duty paid value of the goods and the cost of inland freight to consignee's address.

UNITED KINGDOM

Ginger, unground or ground: 4% (Commonwealth Preference Tariff: free).

To be phased out by 1 July 1977. Added value tax is not charged on foodstuffs in the UK.

HONG KONG

Ginger: duty free.

SINGAPORE

Ginger: duty free.

Appendix IV

Importers of ginger

The following list gives the names of some of the firms which are known to the Tropical Products Institute to be trading in ginger, and also of trade associations which could supply such names. The list should not be regarded as exhaustive. Inclusion in the list does not imply that TPI has any knowledge of the financial standing of the firms.

UNITED STATES OF AMERICA

Details of importers of ginger may be obtained from the following association:
American Spice Trade Association
580 Sylvan Avenue
Englewood Cliffs
New Jersey 07632
USA

CANADA

Details of importers of ginger may be obtained from the following association:
Canadian Spice Association
K I Lister Ltd
833 King Street West
Toronto 2-B
Ontario
Canada

FRANCE

Details of importers of ginger may be obtained from the following association:
Syndicat des Importrateurs, Triturateurs de
Poivres et Epices
52 Avenue Vaillant
93-Pantin
France

NETHERLANDS

Details of importers of ginger may be obtained from the following association:
Nederlandsche Vereeniging voor den
Specerijhandel
P O Box 301
Amsterdam
Netherlands

Firms:

Catz International NV
Blaak 101
P O Box 180
Rotterdam

G de Uries & Zonen NV
Stationsplein 9
Amsterdam

Daarnhouwer & Co's NV
Herengracht 223/225
Amsterdam – C

N V Borsumij-Produkton
Wassenaarseweg 40
Den Haag

FEDERAL REPUBLIC OF GERMANY

Johannes Detmes
Willistrasse 37
2 Hamburg 39

Menke & Co
Grosse Reichen Strasse 27
2 Hamburg 11

Peterson & Paulsen
Kleine Rechenstrasse 21
2 Hamburg 11

Jost Bauer & Co
Hohe Brucke 1
2 Hamburg 11

Walther Paulsen
Virchowstrasse 15
2 Hamburg 50

E H Woerle & Co
Belevue 7
2 Hamburg 39

Ubena Pumpel & Frischen
Hans-Breidhofstrasse 36
28 Bremen

Oricon Warenhandelsges
Peter Hinleinstrasse 16
28 Bremen

JAPAN

Hirasak: Trading Co
45 Harima Machilkutaku
Kobe

Inabata Koryo Co Ltd
16, 6-chome
Tagawadori
Higashiyodagawa-Ku
Osaka

NEW ZEALAND

Gollin & Co Ltd
P O Box 794
Wellington

R Gapes & Co Ltd
P O Box 1311
Wellington

Melville Ford & Co Ltd
P O Box 1374
Wellington

N Z Coffee & Spice Co Ltd
P O Box 4088
Christchurch

Far East Trading Co
High Street
Christchurch

L D Nathan & Co Ltd
P O Box 1034
Auckland

Burns Philp & Co Ltd
P O Box 4118
Auckland

UNITED KINGDOM

Details of importers of ginger may be obtained from the following associations:

British Spice Trade Association
15 Cheapside
London EC3

General Produce Brokers Association of London
Plantation House
Mincing Lane
London EC3

Firms:

Lewis & Peat Ltd
Plantation House
Mincing Lane
London EC3

E D & F Mann Ltd
30 Mincing Lane
London EC3

Messrs Paines & Reed
37 Eastcheap
London EC3

Rucker & Bencraft Ltd
5 Fenchurch Street
London EC3

Clarke & Smith Ltd
61 Crutched Friars
London EC3

Evans, Gray & Hood Ltd
110 Cannon Street
London EC4

Royal Oak Spice Mills
29 Broomfield Street
London E14
(Bryan & Mullinger)

Briggs Abbot & Co Ltd (preserved)
16 Finsbury Circus
London EC2

J A Sharwood (preserved)
10 Victoria Road
London NW10

G Costa & Co Ltd (preserved)
Staffordshire Street
London SE15

Bombay Emporium Ltd
12 Martello Street
London E8

Enco Products Ltd (fresh)
71 Fortress Road
London NW5

Lal Jolly Ltd (fresh)
70 Warwick Avenue
London NW5

Patak Spices Ltd (fresh)
Westbury Mill
Westbury
Nr Brackley
Northants

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The market for edible groundnuts

Tropical Products Institute

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The market for edible groundnuts

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ust 1975

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Ministry of Overseas Development

This report was produced by the Tropical Products Institute, a British Government organisation which helps developing countries to derive greater benefit from their renewable resources.

It specialises in post-harvest problems and will be pleased to answer requests for information and advice.

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Summary and conclusions

The market for edible groundnuts

1. This report deals with the world overseas trade in edible groundnuts, which are defined as those groundnuts which are not crushed for oil, but which are used for human consumption.

2. The report discusses briefly the types of groundnuts traded internationally (groundnuts in-shell and groundnut kernels) and the varietal groups grown (Virginia, Runner, Spanish and Valencia).

3. Quality is discussed in detail. The traditional quality factors for groundnuts in-shell and groundnut kernels are described, namely: pod colour and type, pod texture, size, cleanliness, freedom from damage and blindnuts for in-shells; and grading for size, shape, ease of blanching, skin colour and condition, resistence to splitting, moisture content, cleanliness, oil content and flavour for kernels.

4. The over-riding consideration with regard to quality in the leading importing countries is freedom from aflatoxin which is usually defined as groundnuts containing less than 0.005 ppm B_1 (see page 16). The problems of testing and analysing for aflatoxin have created difficulties for the trade and are partially responsible for the differing standards on aflatoxin contamination in importing and exporting countries. Official regulations and trade practices in importing countries are specified. The strictest of these are in Denmark which prohibits any aflatoxin in imports, and Poland and the Netherlands which apply a tolerance of 0.005 ppm B_1 on retail products. In the Federal Republic of Germany the maximum tolerance on imports is 0.010 ppm and in the UK and Italy 0.050 ppm. The trend in most countries has been towards stricter standards with maximum tolerances being reduced.

5. The requirements regarding aflatoxin have had far-reaching results on the trade in some European countries. For example, many roasters now insist on a supply of aflatoxin-free groundnuts and they place the onus of meeting this requirement on dealers. Naturally the dealers, in turn, buy from sources which in their experience supply aflatoxin-free groundnuts, or provide aflatoxin-free guarantees. Even before aflatoxin was discovered there had been a tendency for the processing industry and the 'dealer' trade to be concentrated into fewer firms, each handling larger quantities. The discovery of aflatoxin and its effects has accelerated this trend since the extra risk involved can be met better by a firm operating on a large scale. The larger users can afford safeguards such as regular testing and electronic sorting machines, while only international dealers are equipped to trade with countries of origin whose exports may involve a risk of contamination at unacceptable levels.

6. An estimate of the size of world trade in edible groundnuts is shown in the table below:

	1965	1968	1969	1970	1971	1972	1973
Groundnut kernels ('000 mt)	245	295	290	315	305	350	380
Groundnuts in-shell ('000 mt)	55	75	85	85	90	95	100
Total (in kernel equivalent) ('000 mt)	285	345	350	375	370	415	450

7. Total supplies of edible groundnuts have increased steadily, despite marked annual fluctuations in individual producing countries, which fortunately have tended to balance each other out. The main supplying countries for groundnut kernels are potentially China, India and the USA: the last named supplied about a third of the total in 1972 and 1973. However, their export performance, especially China's and India's, has been erratic because exports represent supplies marginal to a large domestic demand and can vary from zero to 100,000 tonnes, depending on the size of the harvest. A number of African countries have each supplied around 10% of the total world trade; they include South Africa, Malawi, Nigeria and the Sudan.

8. Trade in groundnuts in-shell has been increasing at a faster rate than trade in kernels; 8% compared with 5% between 1965 and 1972. The premier supplying region for groundnuts in-shell is considered to be the Middle East, but Brazil is apparently the largest single exporting country. The Sudan, China, Madagascar and India are other significant suppliers.

9. The groundnut industries in eight countries (the USA, China, India, South Africa, Nigeria, Senegal, Malawi and the Sudan), are reviewed.

10. The main importers of edible groundnut kernels are the following (with 1972 tonnages shown in brackets): Japan (62,000), the UK (60,000), Canada (49,000), the Federal Republic of Germany (48,000), the Netherlands (40,000), and the USSR (27,000). Imports into all the major consuming countries are shown in Table 12.

1. The main importers of groundnuts in-shell are concentrated in the Mediterranean region, namely (with 1972 tonnages in brackets): Spain (19,000), Italy (16,000) and France (11,000). Imports into all the major consuming countries are shown in Table 13.

2. It has been necessary to estimate imports of edible groundnuts for a number of countries since published import statistics do not always differentiate between imports of edible groundnuts for human consumption and imports for milling into oil and cake. Estimates have been derived from other published and private data, from trade sources, from the value of imports and in some cases the origin of supplies.

3. The main uses for imported edible groundnuts are discussed. The countries with the highest level of per capita imports (Canada and the Netherlands) consume a large proportion as peanut butter. Generally, countries which consume more kernels than groundnuts in-shell have a higher level of consumption than those countries which consume largely groundnuts in-shell. It does not follow that the markets in countries with low per capita imports can be developed by new products such as peanut butter and roasted kernels, since their present patterns of consumption are based on local tastes and social customs.

The strong effect of the price of edible groundnuts on their demand is identified. The very wide differentials in price between edible groundnuts and other edible nuts has insulated the roasted and salted groundnut market from price competition, but changes in relative prices can influence use in sweet confectionery and bakery products.

15. The market for roasted and salted groundnut kernels had appeared to reach saturation point in most of the large importing countries by 1972. Increased competition from other cheap savouries, especially potato crisps, was considered a major cause. However, in 1973, imports of edible groundnuts increased in most of the main consuming markets by 10% or more, probably due to an increase in availability at a time when specially favourable factors influenced demand.

16. The operation of the international marketing system is described. The problem of obtaining aflatoxin free supplies has emphasised the difference in roles between the international dealers, who obtain supplies from origin and make them available to national markets, and the national dealers, who purchase only supplies which fall within the nationally permitted tolerance of aflatoxin and sell them to users on special delivery and financial terms. Some large users trade directly with international dealers or producers. Brokers may operate between all the principals of the trade and the stage at which they are employed tends to vary in the different national markets.

17. The markets in the United Kingdom, the Federal Republic of Germany, the Netherlands, France, Denmark, Italy, Spain, Canada and Japan are discussed in detail. Imports, consumption patterns and quality requirements are covered.

18. The prices of edible groundnuts have been increasing steadily since the mid 1960s. For example, the average annual prices for South African Natals 60/70s cif UK moved within a narrow range around £108 per tonne between 1956 and 1964; the average rose in steps to £135 between 1965 and 1968 and to £163 between 1969 and 1972. In 1973, the average price was £252. The effect of this large price increase may be to curb demand as it reaches the retail level.

19. The main determinant of the price of edible groundnuts is the price of milling groundnuts, which is influenced by the size of groundnut production and the price level of other oilseeds and fats, which can be substituted for groundnuts. The premium for edible grades over milling grades has been fairly constant at around £26 per tonne for the lower quality nuts and up to £80 for the good quality Natals. In periods when there is a shortage of supply the premium may increase, but is unlikely to fall below the cost of selection, which is probably at its lowest level in West Africa, where it is estimated to be £25 per tonne.

20. The price for groundnuts in-shell has been around the same level as the price of groundnut kernels, reflecting higher quality requirements and the ensuing higher costs of production.

21. Since the mid- 1960s, the supply of edible groundnuts has increased steadily and has been sufficient to cover demand. However, the overall demand for edible groundnuts is expected to grow more slowly in the future. The supply situation remains uncertain due to the effect of the drought in West and Central Africa, the inherent unpredictability of exports from China and India and the possibility of either massive increases or decreases in exports from the USA, depending on the shape of the new Federal support programme. The opportunities for producers to increase their exports are likely to be limited unless they can produce high quality aflatoxin-free nuts. Those who do not produce aflatoxin-free nuts stand to lose their current markets due to the introduction of stricter and more uniform standards on aflatoxin in the main importing countries.

RESUME ET CONCLUSIONS

Le marché des arachides comestibles

1. Ce rapport concerne le marché mondial outremer des arachides comestibles; par définition, ce sont les arachides qui ne sont pas broyées pour la production d'huile, mais utilisées pour la consommation humaine.

2. Dans ce rapport, on examine brièvement les types d'arachides mis sur le marché international (arachides non décortiquées et graines d'arachides) et les groupes variétaux cultivés (Virginia, Runner, Spanish et Valencia).

3. Le problème de la qualité est discuté en détail. On décrit les facteurs de qualité classiques pour les arachides non décortiquées et les graines d'arachides, à savoir: couleur et type de la coque, texture de la coque, taille, netteté, absence de détériorations et de défauts pour les produits non décoritqués; classification pour la taille, la forme, la facilité de décorticage, la couleur et l'état de la peau, la résistance à se fendre, la teneur en humidité, la netteté, la teneur en huile et la flaveur pour les graines.

4. En ce qui concerne la qualité, le facteur primordial pris en considération dans les principaux pays importateurs est l'absence d'aflatoxine; ceci est définie habituellement comme une teneur des arachides inférieure à 0,005 ppm de B_1 (voir page 16). Les problèmes de contrôle et d'analyse pour la détermination de l'aflatoxine ont créé des difficultés pour le commerce et sont en partie responsables des normes différentes relatives à la contamination par l'aflatoxine en vigueur dans les pays importateurs et exportateurs. Les réglementations officielles et les pratiques commerciales des pays importateurs sont précisées. Les plus rigoureuses sont celles en vigueur au Danemark, qui interdit toute aflatoxine dans les produits importés, ainsi qu'en Pologne et aux Pays-bas, qui appliquent une tolérance de 0,005 ppm de B_1 pour les produits vendus au détail. En République Fédérale Allemande, la tolérance maximale pour les denrées importées est de 0,010 ppm et au Royaume-Uni et en Italie – de 0,050 ppm. Dans la plupart des pays, la tendance s'est orientée vers des normes plus rigoureuses, avec une réduction des tolérances maximales.

. Les exigences concernant l'aflatoxine ont eu des répercussions de grande portée sur le commerce dans certains pays d'Europe. Par exemple, de nombreux rôtisseurs insistent maintenant sur des livraisons d'arachides exemptes d'aflatoxine et ils mettent les négociants dans l'obligation de satisfaire cette exigence. Naturellement, les négociants achètent, à leur tour, chez des producteurs qui, d'après leur expérience, livrent des arachides exemptes d'aflatoxine ou fournissent des garanties d'absence d'aflatoxine. Même avant la découverte de l'aflatoxine, l'industrie de transformation et le commerce de "distribution" avaient déjà tendance à se concentrer en un petit nombre d'entreprises traitant chacune de grandes quantités. La découverte de l'aflatoxine et de ses effets a accéléré cette tendance, car une entreprise opérant sur une grande échelle peut mieux faire face au risque supplémentaire impliqué. Les plus grands utilisateurs peuvent prendre des mesures de précaution, telles qu'un contrôle régulier et le triage à l'aide de machines électroniques, alors que seuls les négociants travaillant sur le plan international sont équipés pour traiter avec des pays d'origine dont les produits d'exportation peuvent impliquer un risque de contamination à des niveaux inacceptables.

Une estimation de l'importance du marché mondial des arachides comestibles est présentée dans le tableau ci-dessous:

	1965	1968	1969	1970	1971	1972	1973
Graines d'arachides (milliers de tonnes)	245	295	290	315	305	350	380
Arachides non décortiquées (milliers de tonnes)	55	75	85	85	90	95	100
Total (en équivalent de graines, milliers de tonnes)	285	345	350	375	370	415	450

7. Les approvisionnements totaux en arachides comestibles ont augmenté régulièrement, malgré les fluctuations annuelles marquées dans les différents pays producteurs, qui, heureusement, avaient tendance à se contre-balancer. Les principaux pays producteurs de graines d'arachides sont la Chine, l'Inde et les Etats-Unis: ces derniers ont fourni près du tiers du total en 1972 et 1973. Toutefois, les exportations réalisées, surtout en Chine et en Inde, ont été irrégulières, car les produits à l'exportation représentent des approvisionnements en marge d'une forte demande indigène et leur volume peut varier de zéro à 100.000 tonnes, suivant l'importance de la récolte. Un certain nombre de pays africains ont fourni chacun près de 10% du marché mondial total; en font partie l'Afrique du Sud, le Malawi, le Nigeria et le Soudan.

8. Le marché des arachides non décortiquées a augmenté plus rapidement que le marché des graines; 8% par rapport à 5% entre 1965 et 1972. Le Moyen-Orient est considéré comme la première région productrice d'arachides non décortiquées, mais le Brésil semble être le plus grand pays exportateur. D'autres producteurs importants sont le Soudan, la Chine, Madagascar et l'Inde.

9. On passe en revue les industries des arachides dans huit pays (Etats-Unis, Chine, Inde, Afrique du Sud, Nigeria, Sénégal, Malawi et Soudan).

10. Les principaux importateurs de graines d'arachides sont les suivants (tonnages de 1972 indiqués entre parenthèses): Japon (62.000); Royaume-Uni (60.000); Canada (49.000); République Fédérale Allemande (48.000); Pays-Bas (40.000) et URSS (27.000). Les importations dans tous les principaux pays consommateurs sont présentées dans le tableau 12.

11. Les principaux importateurs d'arachides non décortiquées se concentrent dans la région méditerranéenne, à savoir (tonnages de 1972 indiqués entre parenthèses): Espagne (19.000); Italie (16.000) et France (11.000). Les importations dans tous les principaux pays consommateurs sont présentées dans le tableau 13.

12. Il a fallu évaluer les importations des arachides comestibles pour un certain nombre de pays, car les statistiques d'importation publiées ne font pas toujours la distinction entre les importations d'arachides comestibles pour la consommation humaine et les importations pour la transformation en huile et en tourteaux. Les évaluations ont été faites à partir d'autres données publiées et privées, à partir de sources commerciales, à partir de la valeur des importations et, dans certains cas, de l'origine des approvisionnements.

13 On examine les principales utilisations des arachides comestibles importées. Les pays avec les taux les plus élevés d'importations par habitant (Canada et Pays-Bas) consomment une grande proportion sous forme de beurre d'arachides. En général, les pays qui consomment plus de graines que d'arachides non décortiquées ont un taux de consommation plus élevé que les pays qui consomment principalement des arachides non décortiquées. Il ne s'ensuit pas que les marchés dans des pays avec de faibles importations par habitant puissent être développés avec de nouveaux produits, tels que le beurre d'arachides ou les graines grillées, car leurs schemas actuels de consommation sont basés sur les goûts locaux et les coutumes sociales.

14. On indentifie l'effet important exercé par le prix des arachides comestibles sur leur demande. Les très grandes différences dans les prix entre les arachides comestibles et d'autres noix comestibles ont mis le marché des arachides grillées et salées hors de la compétition des prix, mais des variations dans les prix relatifs peuvent influencer l'utilisation dans les produits de confiserie et de pâtisserie.

15. Le marché des graines d'arachides grillées et salées a semblé atteindre, en 1972, un point de saturation dans la plupart des pays de gross importation. On a estimé que la cause en était la compétition croissante de la part d'autres bouchées salées peu chères, en particulier les pommes chips. Mais en 1973, les importations des arachides comestibles ont augmenté sur la plupart des principaux marchés de consommation de 10% et plus, ce qui était dû probablement à une augmentation des produits disponibles à une époque où des facteurs particulièrement favorables ont influencé la demande.

16. On décrit le fonctionnement du système de marketing international. Le problème de l'obtention de denrées exemptes d'aflatoxine a souligné les différences entre les rôles des négociants travaillant sur le plan international qui s'approvisionnent à la source et vendent les produits sur les marchés nationaux, et des négociants travaillant sur le plan national, qui n'achètent que des denrées entrant dans les limites de tolérance d'aflatoxine approuvées sur le plan national et vendent ces denrées aux utilisateurs dans des conditions spéciales de livraison et de financement. Certains gros utilisateurs traitent directement avec des négociants internationaux ou des producteurs. Des courtiers peuvent servir d'intermédiaires entre les principales opérations commerciales et l'étape de leur intervention tend à varier sur les divers marchés nationaux.

17. On examine en détail les marchés du Royaume-Uni, de la République Fédérale Allemande, des Pays-Bas, de la France, du Danemark, de l'Italie, de l'Espagne, du Canada et du Japon. Cette analyse englobe les importations, les schémas de consommation et les exigences de qualité.

8. Les prix des arachides comestibles ont augmenté de façon constante depuis le milieu des années 60. Par exemple, les prix annuels moyens cif Royaume-Uni pour les "Natal" sud-africains 60/70 ont varié dans d'étroites limites autour de £108 par tonne entre 1956 et 1964; le prix moyen a augmenté progressivement à £135 entre 1965 et 1968 et à £163 entre 1969 et 1972. En 1973, le prix moyen était de £252. L'effet de cette forte augmentation de prix peut être une répression de la demande lorsqu'elle atteint le niveau de la vente au détail.

9. Le facteur déterminant agissant en premier lieu sur le prix des arachides comestibles est le prix des arachides destinées au broyage, qui est influencé par l'importance de la production d'arachides et par le prix d'autres graines oléagineuses et graisses pouvant se substituer aux arachides. La prime au bénéfice des qualités comestibles par rapport aux qualités destinées au broyage est restée pratiquement constante aux environs de £26 la tonne pour les arachides de moindre qualité et jusqu'à £80 la tonne pour les arachides "Natal" de bonne qualité. Au cours de périodes d'approvisionnement insuffisant, la prime peut augmenter, mais il est peu probable qu'elle tombe au-dessous du coût de sélection, qui est à son niveau le plus bas en Afrique de l'Ouest, où on l'estime á £25 la tonne.

). Le prix des arachides non décortiquées est resté à peu près au même niveau que le prix des graines d'arachide, reflétant des exigences de qualité supérieure et les coûts plus élevés de production qui s'ensuivent.

. Depuis le milieu des années 60, l'approvisionnement en arachides comestibles a augmenté de façon constante et il a été suffisant pour couvrir la demande. Toutefois, on s'attend à ce que la demande pour les arachides comestibles

augmente plus lentement dans l'avenir. La situation de l'approvisionnement reste incertaine en raison de l'effet de la sécheresse en Afrique Occidentale et Centrale, du caractère imprévisible des exportations de Chine et de l'Inde et de là possibilité soit d'augmentations soit de diminutions massives des exportations des Etats-Unis, suivant le profil du nouveau programme de soutien Fédéral. Les occasions pour les producteurs d'augmenter leurs exportations sont susceptibles d'être limitées, à moins qu'ils ne puissent produire des arachides exemptes d'aflatoxine, de qualité élevée. Ceux qui ne produisent pas des arachides exemptes d'aflatoxine risquent de perdre leurs marchés habituels en raison de l'introduction de normes plus rigoureuses et plus uniformes sur l'aflatoxine dans les principaux pays importateurs.

RESUMEN Y CONCLUSIONES

El mercadeo de cacahuetes comestibles

1. Este informe trata del comercio exterior de los cacahuetes comestibles, es decir de los cacahuetes que no se molturan para la obtención de aceite, sino que se utilizan para el consumo humano como tales.

2. Se describen, brevemente, los tipos de cacahuetes comercializados internacionalmente (cacahuetes en cáscara y descascarados) y los grupos varietales cultivados (Virginia, Runner, Spanish y Valencia).

3. Se tratan con detalle las características de calidad. Tradicionalmente, la calidad de los cacahuetes en cáscara y descascarados se define principalmente por los factores siguientes: tipo y color de la cáscara, textura de la cáscara, tamaño, limpieza y ausencia de daños en las almendras o frutos vanos para los cacahuetes en cáscara; y uniformidad de tamaño, forma, facilidad de blanqueo, condición y color de la piel, resistencia al resquebrajamiento, contenido de humedad, limpieza, contenido de aceite y aroma para los cacahuetes descascarados.

4. La principal exigencia de los paises importadores más importantes, respecto a la calidad, es que los cacahuetes estén libres de aflatoxina, lo cual se define como cacahuetes que contienen menos de 0,005 ppm de B_1 (ver pág. 16). Los problemas que plantean los ensayos y análisis de aflatoxina han creado dificultades en el comercio, y son en parte responsables de las diferentes normas sobre contenido de aflatoxina existentes en los distintos paises importadores y exportadores. Se especifican las normas oficiales y prácticas comerciales de los paises importadores. Las más estrictas son las establecidas por Dinamarca que exigen la total ausencia de aflatoxina en los cacahuetes importados, y las de Polonia y Holanda que aplican una tolerancia máxima de 0,005 ppm de B_1 en los productos al por menor. En la República Federal de Alemania la tolerancia máxima sobre los importados es de 0,010 ppm y en el Reino Unido e Italia de 0,050 ppm. En la mayoría de los paises, la tendencia actual es la de establecer normas cada vez más estrictas, reduciendo los límites de tolerancia.

5. Las exigencias relativas a la aflatoxina se han traducido ya en consecuencias de largo alcance en el comercio de cacahuetes en algunos paises europeos. Por ejemplo muchos tostaderos exigen en la actualidad a sus suministradores el aprovisionamiento de cacahuetes libres de aflatoxina, los cuales trasladan este cometido a los traficantes. A su vez, como es lógico, los traficantes adquieren los productos de fuentes que, por experiencia, saben que proporcionan los cacahuetes exentos de aflatoxina u ofrecen garantías sobre la carencia de la misma. Ya, incluso antes del descubrimiento de la aflatoxina, había una tendencia a concentrar la industrialización y el comercio en menor número de firmas, manipulando cada una mayor

cantidad de productos. El descubrimiento de la aflatoxina y sus efectos han acelerado esta tendencia ya que los riesgos existentes pueden evitarse mejor en firmas que operen en gran escala. Las grandes empresas están capacitadas para poder contar con medidas de protección tales como ensayos regulares de aflatozina y máquinas electrónicas de clasificación, así como sólo las grandes firmas comerciales están equipadas para comerciar con paises de origen cuyas exportaciones puedan incluir el riesgo de contaminación a niveles inaceptables.

6. La tabla siguiente muestra una estimación del volumen del comercio mundial de cacahuetes comestibles:

	1965	1968	1969	1970	1971	1972	1973
Cacahuetes descascarados ('000 Tm)	245	295	290	315	305	350	380
Cacahuetes en cáscara ('000 Tm)	55	75	85	85	90	95	100
Total (equivalente en cacahuetes descascarados) ('000 Tm)	285	345	350	375	370	415	450

7. El total de la oferta de cacahuetes comestibles se viene incrementando de modo continuo, a pesar de las marcadas fluctuaciones anuales existentes en los distintos paises productores, que afortunadamente han tendido a compensarse. Los principales paises proveedores de cacahuet descascardo son, potencialmente, China, India y Estados Unidos, siendo este último el proveedor de un tercio, aproximadamente, del total de la oferta en 1972 y 1973. Sin embargo, el volumen de sus exportaciones, especialmente de la China e India, ha sido variable, ya que las mismas representan una oferta marginal de su gran demanda interior y pueden variar desde cero a 100,000 toneladas, dependiendo del volumen de la cosecha. Cierto número de paises africanos han suministrado cada uno el 10 por 100 del total del comercio mundial, entre los que se incluyen Sud-Africa, Malawi, Nigeria y El Sudán.

8. El comercio mundial de cacahuetes en cáscara se ha incrementado proporcionalmente de forma más rapida que el de los descascarados; un 8 por 100 comparado a un 5 por 100 entre 1965 y 1972. La principal región suministradora de cacahuetes en cáscara es el Oriente Medio, pero Brasil es el país individual exportador mas importante. Otros paises productores importantes son El Sudán, China, Madagascar y la India.

9. Se estudia la producción de cacahuet en ocho paises (Estados Unidos, China, India, Sud-Africa, Nigeria, Senegal, Malawi y El Sudán).

10. Los principales paises importadores de cacahuetes comestibles descascarados (indicandose entre paréntesis las toneladas importadas en 1972) son los siguientes: Japón (62.000), Reino Unido (60.000), Canadá (49.000), República Federal de Alemania (48.000), Holanda (40.000) y la U.R.S.S. (27.000). Las importaciones de todos los principales paises consumidores se muestran en la Tabla 12.

11. Los principales paises importadores de cacahuetes en cáscara se encuentran en la región mediterránea, siendo los más importantes (indicándose entre paréntesis las toneladas importadas en 1972): España (19.000), Italia (16.000) y Francia (11.000). Las importaciones de todos los principales paises consumidores se muestran en la Tabla 13.

12. Para un cierto número de paises, se ha tenido que hacer una estimación de las importaciones de cacahuetes comestibles, ya que las estadísticas publicadas de importación no diferencian siempre las importaciones para consumo humano y las destinadas a molienda para aceite y tortas. Estas estimaciones se han realizado basándose en otros datos publicados y privados, en fuentes comerciables, en el valor de las importaciones y en algunos casos en el origen de los suministros.

13. Se discuten los principales usos de los cacahuetes comestibles importados. Los paises con mayor nivel de importacion per capita (Canadá y Holanda) consumen una gran proporción como mantequilla de cacahuete. Generalmente, los paises que consumen más cacahuetes descascarados que en cáscara tienen mayor nivel de consumo que los que consumen mayor cantidad de cacahuetes en cáscara. No se puede deducir que, en los paises con menor importación per capita, pueda desarrollarse el mercado a base de nuevos productos como mantequilla de cacahuet y cacahuetes descascarados tostados, ya que sus actuales características de consumo se basan en los gustos locales y en las costumbres sociales.

14. Se muestra la gran influencia del precio sobre la demanda. Las grandes diferencias de precio entre los cacahuetes y otros frutos-nuez comestibles han aislado el mercado de cacahuetes salados y tostados de la competencia de precios, pero los cambios relativos de precios pueden influir en su utilización en confitería y pastelería.

15. El mercado de cacahuetes descascarados salados y tostados percía haber llegado al punto de saturación en la mayoría de los principales paises importadores en 1972. La causa principal de ello se atribuye a la competencia creciente de otros productos baratos de utilización similar como aperitivos, especialmente patatas fritas a la inglesa. Sin embargo, en 1973, las importaciones de cacahuetes comestibles aumentaron en la mayoría de los principales mercados consumidores en un 10 por 100 o más, debido, probablemente, a un incremento de su disponibilidad en un momento dado, cuando determinados factores favorables influyen sobre la demanda.

16. Se describe el sistema operacional del mercadeo internacional. El problema de obtener partidas libres de aflatoxina ha agrandado la diferencia de las funciones entre los traficantes internacionales, que obtienen suministros de las zonas productoras y los venden en los mercados nacionales, y los traficantes nacionales, que compran solamente partidas con proporción de aflatoxina incluída dentro de los limites de tolerancia permitidos nacionalmente y los venden a los compradores en términos especiales de financiación y entrega. Algunas grandes firmas comercian directamente con los traficantes internacionales y los productores. Los intermediarios pueden operar entre los principales eslabones de la cadena comercial y los estadios en que intervienen tienden a variar en los diferentes mercados nacionales.

17. Se describen con detalle las características de los mercados del Reino Unido, la República Federal de Alemania, Holanda, Francia, Dinamarca, Italia, España, Canadá y Japón. En esta descripción se incluyen las importaciones, las modalidades de consumo y las exigencias de calidad.

18. Desde mediados los años 60, los precios de los cacahuetes comestibles se han incrementado de forma continua. Por ejemplo, el precio medio anual CIF-Reino Unido, de los cacahuetes Natals procedentes de Sud-Africa, osciló con escasa variación alrededor de las 108 libras por tonelada entre 1956 y 1964; el precio medio se elevó paulatinamente a 135 libras entre 1965 y 1968 y a 163 libras entre 1969 y 1972. En 1973, el precio medio fue de 252 libras. El efecto de este gran incremento de precio puede traducirse en un freno de la demanda si afecta al nivel de venta al por menor.

19. El factor principal determinante del precio de los cacahuetes comestibles es el precio de los cacahuetes destinados a molienda, el cual está influenciado por la magnitud de la producción de cacahuetes y el nivel de precios de otras semilla oleaginosas y otras grasas, que pueden ser sustituidas por cacahuetes. La diferencia de precio a favor de las calidades comestibles sobre las calidades destinadas a molienda se ha mantenido bastante constante, alrededor de 26 libras por tonelada para las variedades de calidad inferior llegando hasta las 80 libras para las Natals de buena calidad. En los periodos que se presenta una escasez de la oferta, la diferencia de precio puede incrementarse y, por el

contrario, es improbable que caiga nunca por debajo del costo de selección, el cual se estima en 25 libras por tonelada en Africa Occidental, donde probablemente el nivel de costos es el menor.

20. El precio de los cacahuetes en cáscara ha fluctuado alrededor del mismo nivel que el de los cacahuetes descascarados, reflejando las mayores exigencias de calidad y los consiguientes costos superiores de producción.

21. Desde mediados de los años 60, la oferta de cacahuetes comestibles se ha incrementado continuamente y ha sido suficiente para satisfacer la demanda. Sin embargo, el total de la demanda de cacahuetes comestibles se espera que crezca más lentamente en el futuro. La situación de la oferta permanece incierta, debido al efecto de la sequía en Africa Central y Occidental, la imposibilidad existente de predecir las exportaciones de China y la India y la possibilidad tanto de un gran aumento como de una gran disminución de las exportaciones de los Estados Unidos, dependiente de las características del nuevo programa de apoyo federal. Las oportunidades para los productores de incrementar sus exportaciones serán limitadas, a menos que puedan producir cacahuetes de alta calidad libres de aflatoxina. Los que no produzcan cacahuetes libres de aflatoxina están abocados a perder sus mercados actuales debido a la introducción en los principales paises importadores de normas más estrictas y uniformes sobre la aflatoxina.

Introduction

This report describes the world overseas trade in edible groundnuts. It is a revised edition of an earlier report of the Institute entitled 'The market for edible groundnuts' (Winter 1968). Edible groundnuts are those which are intended for direct human consumption as distinct from those which are milled into oil and cake.

The report is divided into five parts. Part I deals with the types of edible groundnuts, varietal groups and the quality requirements for export. Part II summarizes world exports of edible groundnuts and reviews the groundnut industries in some of the larger producing countries. Part III discusses imports of edible groundnuts, patterns of consumption and marketing systems. The markets in some of the major importing countries are also described. Part IV details the trends in edible groundnut prices and their relationship to milling grade prices. Part V draws together the conclusions of the study and evaluates the prospects.

Field research was carried out by the author in seven countries – Canada, the USA, the Federal Republic of Germany, the Netherlands, Switzerland, France and the UK. This work enabled the author to identify varying usage patterns, type/quality preferences, to confirm quantitative assessments of national markets and to study marketing structures.

Part I

Types of groundnuts traded internationally

Groundnuts for edible purposes have traditionally been referred to as 'hand-picked selected' or 'HPS'; in other words, a large measure of hand sorting is necessary to obtain the required quality. 'Machine sorting' may be used for some part of the selection process, although it is rare outside the USA for selection to be done entirely by machine.

Groundnuts are traded in shell and as kernels, although the quantity traded as kernels is by far the greater. Most groundnuts in shell are for direct human consumption, while the larger proportion of kernels is used for milling. However, the trend in recent years has been for milling to be done increasingly in producing countries and for the products to be exported. As a result, edible groundnuts make up an increasing proportion of total kernel exports, approaching 40% in 1972.

VARIETAL GROUPS OF GROUNDNUTS

There are four main groups grown in the USA, according to an American publication (Webster 1964). They are Virginia, Runner, Spanish and Valencia. Similar groups are found in other producing countries. These types are described briefly below.

Virginia The pod is large with a marked constriction between the kernels and this accounts for the even taper at each end of the kernels. The pod normally contains two large kernels, which have a light reddish skin.

Runner This type produces typically two medium-sized kernels. Since there is rarely any marked constriction in the pod between the kernels, their interfaces are usually flattened.

Spanish The pod, which is thin, is usually constricted between the kernels and the kernels are almost round. There are normally two small kernels. Their skin is generally thin, easy to remove and a pink or light brown colour. The Natal Common groundnut grown in South Africa is of this type.

Valencia The pod is smooth and there is rarely any marked constriction between the individual kernels, which in consequence are often flattened at the ends. There are usually three kernels in the pod. The skin colour of the kernels varies between pink and red.

These varietal group names are commonly used in the edible or HPS groundnut trade. In addition, edible groundnuts are usually defined by country of origin and count, ie the number making up an ounce, for example USA Virginias 30/32.

QUALITY

This section describes the traditional quality factors for in-shells and kernels and concludes with a discussion of the problem of aflatoxin, which applies to both.

Quality requirements for edible groundnut kernels

Grading Kernels are normally graded into sizes which conform to counts per ounce. Kernels which count 60 to 80 per ounce are regarded as small, 40 to 60 as medium, 30 to 40 as large and 20 to 30 as very large. For small kernels, counts have a range of ten, ie 60/70 or 70/80; for medium and large kernels, a range of five is preferred, ie 40/45 or 50/55, and for very large kernels, a range of two is required, ie 20/22.

It is especially important since the introduction of electronic sorting machines into users' factories that all the groundnuts supplied against a particular count should fall within the permitted range. Those which do not, may follow a trajectory in processing which evades the range of the electronic eye of the sorting machine, which will be set to deal with the trajectory from the anticipated count.

The exports of the world's leading suppliers can be divided roughly according to size as follows:

large	**medium**	**small**
China	Nigeria	US Spanish
Malawi	Brazil	South Africa
US Virginias	US Runners	Sudan
	Indian Bolds	Indian Javas

Shape Kernels of a regular and uniform shape are highly valued in some markets for use as roasted nuts. One reason for the premium on Chinese nuts is that they are consistently regular in shape.

Quality requirements for edible groundnuts in-shell

Pod colour and type The highest quality produce has a bright creamy pod of the Virginia type. These are known as 'fancy' grades; darker shells are known as 'naturals'. Virginia and Valencias are the main types sold in-shell.

Size In the most selective markets the two-seeded type is preferred and the best of these have counts of 10/12 pods per ounce. Three-seeded pods are also widely marketed.

Pod texture The pod should be thick since it can then be roasted without disintegrating. Thin shelled nuts, as from Ethiopia, are consumed unroasted in the UK.

Cleanliness The pods should be cleaned of dirt and of other foreign matter before export. This is necessary to arrive at a fair weight and prevents roasting machines becoming dirty.

Freedom from damage The pods should not be damaged mechanically or by water or scarified, for example, by insects. Broken ends are especially undesirable as they lead to a loss of kernels and are liable to be burnt in roasting.

Absence of blindnuts The presence of blindnuts, or 'pops' according to some trade terminology, lowers the quality. Most contracts also stipulate a maximum percentage of single kernel pods, normally 2%.

Ease of blanching Kernels should blanch easily without splitting or chipping. Old and shrivelled kernels and kernels with flattened ends tend to be more difficult to blanch.

Skin colour and condition The colour of the skin (testa) of the kernel should not be variegated in colour, pink or light brown colours are preferred. If the skin is variegated in colour or broken, the kernels under the variegated or broken part roast a different colour from the rest. Kernels with dark red skins are not liked and this characteristic appears to be associated with kernels which are difficult to blanch.

Resistance to splitting The kernels should so far as possible be whole. In some markets, roasted splits are sold separately. The tendency to split is commonly associated with low moisture content of the kernel.

Moisture content The maximum moisture content which is normally acceptable is 7%. A moisture content above that level encourages mould growth and leads to an unacceptable loss in weight on processing. A figure of 5½ to 7% should be aimed at.

Cleanliness Kernels should be free of all foreign matter such as stones, soil, bits of pods, etc. This is an aspect in which USA groundnuts, which are machine sorted, fall below the highest standards of HPS.

Groundnuts should also be treated to ensure they are free from insect infestation at time of export. However, exporters must ensure that any insecticide or fumigant residue remaining on the nuts does not exceed the limits permitted in importing countries.

Oil content It was formerly considered that an edible groundnut should have a relatively low oil content, that is of 42 to 45%. This requirement is not considered important nowadays, but the oil content does affect the cooking time for roasting the kernels. The oil content is also less important for peanut butter manufacture due to the introduction of oil stabilizers. However, the free fatty acid (FFA) content of the oil must be less than 1% or the kernels will be unsuitable for direct human consumption. The level of FFA may affect the shelf life of the retail product, for example, it is reported by a confectionery manufacturer that Chinese and Malawi nuts become stale relatively quickly if packed in a non-vacuum pack or used in sweet confectionery, while good quality Nigerian and Natal kernels have longer shelf lives.

Flavour Since this is of course a subjective judgement, taste preferences can be influenced by promotion and advertising. Thus there are differences in taste preferences between European countries, although the taste factor is probably of secondary importance compared with size of kernels and general appearance.

The problem of aflatoxin

Freedom from aflatoxin is regarded in a growing number of countries as a prerequisite for imports of edible groundnuts.

Aflatoxin is the term applied to the toxic metabolites produced by some strains of fungi of the *aspergillus flavus* group. Four major toxins may be produced by such strains of *A. flavus* and these have been designated aflatoxins B_1, B_2, G_1 and G_2, of which B_1 is the most toxic and carcinogenic. The problem of aflatoxin first came to prominence as a result of investigations into the cause of death of a number of turkey poults in the United Kingdom in 1960. Investigations showed that the deaths were due to toxins contained in the groundnut meal which formed part of the birds' feed, and that these toxins were the result of the growth of *A. flavus* on the groundnuts from which the meal had been made. It has subsequently been shown that, given suitable conditions, *A. flavus* may grow on a wide variety of commodities, but the incidence of aflatoxin contamination in groundnuts appears to be particularly high. Although there is no direct evidence concerning the effect of aflatoxin on humans, the fact that it is a powerful hepatoxin and carcinogen for certain animal species indicates the desirability of excluding aflatoxin from the human diet.

As it has been difficult to determine levels of aflatoxin B_1 of less than 0.005 ppm, any material tested which gives results below this level has been regarded as free of aflatoxin for practical purposes. 'Free of aflatoxin' and 'aflatoxin-free' are terms used extensively in this report since they are in common usage in the trade. It should be noted, however, that it is now possible to measure aflatoxin B_1 down to 0.001 ppm.

A major problem with regard to aflatoxin is the difficulty of obtaining a representative sample for analysis, since aflatoxin, if present, may be found at high levels in a very small proportion of nuts within the bulk. It is very much a matter of chance if these nuts are included in the sample, as small samples are taken from every fourth bag at most, while sampling of every tenth bag is more usual. If the sample is split subsequently so that more than one test may be made, it is likely that the separate tests will show different results.

Only two Western European countries, the Netherlands and Denmark, have legislation specifically dealing with the aflatoxin problem. In the Netherlands, the sale of any edible groundnut product containing any aflatoxin is prohibited; the maximum tolerance is 0.005 ppm B_1. In Denmark, a statutory order imposes a zero tolerance on imports. In most other West European countries the public health laws provide the consumer with safeguards against sales of foodstuffs containing harmful or poisonous substances, but none specifies aflatoxin or the permitted level of this contaminant. However, it is likely that prosecutions relating to the presence of aflatoxin could take place under these laws.

In January 1975, legislation came into force in the Federal Republic of Germany restricting the maximum tolerance in imports to 0.010 ppm $B_1 + B_2 + G_1 + G_2$ and 0.005 ppm for B_1 alone. Previously, users had established an unofficial standard that imports should not contain more than 0.020 ppm of aflatoxin. In the UK, raw groundnuts are generally sampled and tested on import by the Port Health Authorities under existing health regulations. Lots are, it is understood, rejected for human consumption if they contain more than 0.050 ppm aflatoxin $B_1B_2G_1G_2$. In Italy the maximum tolerance is 0.005 ppm applied on imports. In all the countries mentioned above, many of the importers and users augment routine inspections carried out by public health officers by having imported groundnuts tested at their own expense. The larger users have also introduced electronic sorters into their production lines to assist in reducing the aflatoxin content in their retail products to acceptable levels. This is especially necessary where they are exporting to countries with strict standards on the retail product, particularly the Netherlands, and these pressures of international trade have tended to a uniformity of standards amongst the major roasters and processors in Europe.

Poland interprets its general hygiene regulations on foodstuffs to prohibit the presence of aflatoxin in retail products and the German Democratic Republic is believed to allow a maximum tolerance of 0.005 ppm on imports.

In Canada, the Food and Drug Act does not contain any specific reference to aflatoxin, but importers and users are employing the guideline suggested in the USA. This allows 0.025 ppm of aflatoxin $B_1 + B_2 + G_1 + G_2$ in imported raw groundnuts and 0.020 ppm in the retail product.

Where a sample of a shipment intended for human consumption is found on arrival to have levels of aflatoxin above the maximum permitted, the first reaction of importers is to call for a fresh sample to discover if the first sample was representative. Should subsequent samples confirm excess levels of aflatoxin, the lot may be re-shipped to countries with higher tolerances or may be sold for bird-feeding. In either case, heavy losses are likely to result. It is no longer normal for contaminated edible groundnuts to be milled into oil and cake since there is little demand for milling groundnuts outside France and Italy and the financial losses are even heavier.

The effects of aflatoxin on the trade have been considerable. The remarks which follow originally concerned the Netherlands, but as other countries followed the Netherland's lead on legislation or codes of practice the same effects have followed.

The first effect is that roasters have placed the onus on the dealers of supplying at the factory groundnuts which fall within the nationally permitted tolerance on aflatoxin. In consequence the dealers have placed a higher value on groundnuts from origins with a reputation for supplying aflatoxin-free shipments than on supplies from those origins whose shipments have on occasions been rejected due to excessive aflatoxin. They have put pressure on exporters to give aflatoxin-free guarantees with every shipment and thereby accept responsibility for any rejections. South Africa and Malawi sell their groundnuts on the basis that the level of aflatoxin B_1 will not exceed 0.005 ppm while USA exports are accompanied by warrants guaranteeing that the amount of aflatoxins $B_1 B_2 G_1 G_2$ will not exceed 0.025 ppm. Apart from these countries no exporting country is believed to offer guarantees, although the Sudanese exporting authorities and German importers and users collaborate very closely to select parcels of low aflatoxin content. Chinese exports are said to be always free of aflatoxin. A number of exporting countries are opposed to guarantees on the grounds that the problems of sampling make it impossible to ensure shipments are aflatoxin-free.

The second effect of aflatoxin is that it has accentuated the stratification of the market structure into large international dealers and smaller national dealers. Only those dealers who handle large quantities and have representatives in producing countries which have a poor record on aflatoxin are equipped to bear the risks involved in guaranteeing supplies and disposing of contaminated shipments. There is also a tendency for small users to be eliminated since the larger firms can negotiate from strength when stipulating conditions concerning aflatoxin. Furthermore, only these large firms can afford either the electronic sorters which are necessary in each production line to sort lower quality produce or alternatively the price of top-quality, aflatoxin-free nuts.

The third effect of aflatoxin, which follows from the first two, is that other producers of edible groundnuts may find it increasingly difficult to retain part of the market if Chinese, South African, USA and other guaranteed groundnuts are in good supply and if they remain aflatoxin-free. It is, therefore, imperative that those countries which have a share of the trade do all they can to ensure that their product is aflatoxin-free, since lost confidence would be difficult or impossible to recover, and that 'new' suppliers should ensure that their product is aflatoxin-free before attempting to sell it.

Part II

World trade in edible groundnuts

Table 1, below, illustrates the increase in the quantities of edible groundnuts imported into the main consuming countries.

Table 1

Edible groundnut exports to the main consuming countries ('000 tonnes)

	1965	1968	1969	1970	1971	1972	1973
Kernels	245	295	290	315	305	350	380
In-shell	55	75	85	85	90	95	100
Total (kernel equivalent)	285	345	350	375	370	415	450

Notes: 1. In-shell have been converted to kernel equivalent on the basis of shelled weight being equal to 70% of unshelled weight

2. The figures have been rounded to the nearest 5,000 tonnes

Sources: Tables 2 and 4

The division of world trade in edible groundnuts between kernels and in-shells has been fairly stable. In-shells have accounted for between 14% and 18% and kernels for the balance.

The rate of increase between 1965 and 1972 was just over 5% per annum for the trade in kernels and about 8% for the trade in in-shells.

EXPORTS

Most groundnut producing countries do not differentiate in their foreign trade statistics between exports of edible and milling grades. It has therefore been necessary to work back from import data to arrive at figures for apparent exports of edible grades. In order to be consistent, this method has been applied to all the exporting countries shown in Tables 2 and 4 below, even in those rare cases where reliable export statistics for edible grades are available.

Exports of edible groundnut kernels

Although the trade in edible groundnut kernels has been following a long term upward trend, it has varied from year to year due largely to the constraints of export availability.

Seven countries each have the capacity to supply 30,000 tonnes or more, equivalent to about 10% of world trade, but the trade has been affected most by the performance of the three largest suppliers, the USA, India and China.

Table 2

Edible groundnut kernels: apparent exports to the main consuming countries ('000 tonnes)

	1968	1969	1970	1971	1972
Total	392.6	291.1	313.9	305.2	348.7
of which from:					
USA	55.7	27.3	54.5	75.6	113.5
Brazil	6.5	3.3	20.2	11.4	7.4p
Americas sub-total	62.2	30.6	74.7	87.0	120.9p
Malawi	31.4	29.6	27.8	24.9	22.8
Republic of South Africa	21.8	24.7	37.6	33.2	33.5
Zambia	6.1	3.5	4.1	3.2	4.3
East Africa	4.2	2.5	2.5	1.7	0.2
Mozambique	3.3	2.0	0.6	1.6	1.5
Southern Africa sub-total	66.8	62.3	72.6	64.6	62.3
Nigeria	33.9	31.2	30.2	20.8	14.3
Senegal	1.5	0.2	8.9	5.3	7.5
Sudan	17.8	33.7	28.3	33.0	23.7
Other West and North African countries	4.6	5.0	3.4	3.2	7.3
Northern Africa sub-total	57.8	70.1	70.8	62.3	52.8
China	51.6	40.2	12.7	16.0	39.6
India	17.0	42.9	41.7	36.1	40.5
Indonesia	12.9	17.7	18.7	16.5p	9.7p
Other Asian countries	6.4	7.6	5.9	4.8	3.1p
Asian sub-total	87.9	108.4	79.0	73.4p	92.9p
Australia	0.4	0.9	0.3	0.9	2.7
Netherlands	1.5	5.4	2.5	3.5	4.7
Federal Republic of Germany	1.1	1.5	2.4	1.7	1.1
United Kingdom	0.8	0.7	1.1	0.3	0.6
Re-exports from other countries	0.4	0.6	2.9	0.9	0.7
Re-exports sub-total	3.8	8.2	8.9	6.4	7.1
Other exports	13.7	10.6	7.6	11.6	10.0

Notes: 1. It has been necessary to include a balancing item because the totals for a number of the smallest exporters have not been included and because it is not possible to identify the origin of imports recorded under the heading 'other countries' in import statistics

2. p = provisional

Source: National import statistics

Table 2 shows exports of edible groundnut kernels from the main exporting countries.

In the cases of India and China, their export performance has been highly erratic: India withdrew from the export market altogether in the mid 1960's, but re-established her exports at around 40,000 tonnes from 1969 onwards; in the 1973/74 season they may have reached 100,000 tonnes. Chinese exports have tended to move in the opposite direction; after stabilizing at around 50,000 tonnes in the mid 1960's, they declined to below 15,000 tonnes in 1970. They eventually recovered in 1972 to 40,000 tonnes, but the underlying supply position has continued to be tight. These extreme variations occur because Indian and Chinese exports, which are entirely HPS grades, are supplies marginal to domestic requirements. They represent at most 2% of total production. If the harvest is poor or domestic demand for groundnut products increases, the marginal supplies are diverted to domestic usage rather than export. If the harvest is excellent, as in India in 1973, it produces proportionally a much larger increase in marginal supplies and exports.

The growth in world exports in the 1970's has been due mainly to the increase in exports from the USA. Her exports had been fairly stable at around 50,000 tonnes between 1965 and 1970, with the exception of 1969 when they dropped to 27,000 tonnes. However, by 1972 they had doubled to 113,000 tonnes when they accounted for a third of total exports; this higher level was maintained in 1973. This increase in exports was prompted by the pressure of increasing production

and the difficulty of disposing of it domestically. The steady rise in oilseed prices and the shortage of edible grades from other origins made it easier and more profitable for the USA to sell its surplus overseas. The USA was also anxious to export more agricultural produce to assist in correcting its balance of payments deficit. It is by no means certain that all these factors will persist and the export level could change dramatically in either direction.

African countries also increased their production, especially in the period up to 1970. Table 3 compares African production in 1965, 1970 and 1972. Malawi and the Sudan have created a very strong demand for their kernels by concentrating on one market each, the UK and the Federal Republic of Germany, respectively, and have developed their production to meet the specialized requirements of these markets. The Republic of South Africa has established an excellent reputation for her edible kernels and production has responded to the premium prices received. On the other hand, according to the trade, West African exports have become less acceptable due to stricter quality standards in consuming countries and have been hit on the production side by the persistent drought.

Table 3

Apparent exports of edible groundnut kernels from certain African countries ('000 tonnes)

	1965	1970	1972
Malawi	19	28	23
Nigeria	22	30	14
Republic of South Africa	23	38	34
Sudan	16	33	24

Total exports from Africa declined to 115,000 tonnes in 1972 after advancing to 143,000 tonnes in 1970 from 125,000 tonnes in 1968.

Exports of edible in-shell groundnuts

Table 4 shows the exports of in-shell edible groundnuts between 1968 and 1972. Exports of in-shell nuts came from a considerable number of countries, each supplying a small part of the whole. Brazil is the largest exporter and is estimated to supply one quarter of the total, but she does not dominate the market because her exports are concentrated on Spain where quality standards are less rigorous than elsewhere in Europe. The Middle East, together with the North-East of Africa, is generally regarded as the main supplying area. Quality standards are generally high where the State has intervened in export marketing as in the main exporting countries of Israel, Egypt and the Sudan. Israel had been steadily increasing her production and expected to export 25,000 tonnes by 1975 (Rozenberg, 1971). However, the steep rise in the price of cotton has made it a more profitable commodity for production on the irrigated lands in Israel where groundnuts are grown. As a result, production of in-shell groundnuts will not increase as previously predicted and may actually decline from 1975 onwards.

Other exporters with a reputation for reliable quality are Madagascar, Mexico and China, although the availability from the latter country is as variable as her supply of kernels. The USA has entered this field in a significant way in the last two years and India is also increasing her in-shell exports, mainly to Eastern Europe.

Table 4

Edible groundnuts in shell: apparent exports to the main consuming countries ('000 tonnes)

	1968	1969	1970	1971	1972
Total	75.0	86.5	85.7	88.5	96.2
of which from:					
Brazil	2.8	22.1	26.3	22.7	24.8
Mexico	3.0	2.1	2.7	3.6	2.8
USA	0.3	0.2	1.1	3.4	6.1
Americas sub-total	6.1	24.4	30.1	29.7	33.7
Ethiopia	1.7	2.3	0.9	1.0	0.7
Madagascar	4.8	3.5	2.5	4.1	2.8
Senegal	0.1	0.3	1.4	1.4	0.7
Sudan	13.9	17.0	11.7	8.4p	8.0p
African sub-total	20.5	23.1	16.5	14.9p	12.2p
Egypt	7.2	8.2	7.5	7.0p	7.5p
Israel	4.3	5.7	6.7	9.4	11.1
Lebanon	1.2	1.6	1.2	0.6	0.4
Libya	11.4	1.6	0.3	1.1	2.7
Syria	3.9	4.4	3.0	1.1	1.5
Turkey	1.3	1.4	2.5	5.4	4.3
Middle-East sub-total	29.3	22.9	21.2	24.6p	27.5p
China	9.8	7.9	3.7	6.5	8.1
India	0.6	1.5	2.0	5.0	6.4
Indonesia	2.4	1.5	1.5	0.7p	0.1p
Other Asian countries	2.2	2.0	3.8	2.8p	0.8p
Asia sub-total	15.0	12.9	11.0	15.0p	15.4p
Re-exports in Europe	2.7	2.3	2.4	1.6	1.1
Other exports[1]	1.4	0.9	4.5	2.7	6.3

Notes: 1. It has been necessary to include a balancing item because the totals for a number of the smallest exporters have not been included and because it is not possible to trace the origin of imports recorded under the heading 'other countries' in import statistics.

2. p = provisional.

Sources: National import statistics.

REVIEW OF THE GROUNDNUT INDUSTRIES IN CERTAIN EXPORTING COUNTRIES

The USA

The USA produces mainly edible quality nuts, but about a third of its exports are estimated to be for milling. Edible quality exports have been almost entirely shelled grades. In-shell exports have only increased in recent years. For edible groundnut exports from the USA see Table 5 below.

The Runner type has passed the Spanish and Virginia as the most commonly exported type in the 1970's. In the 1972/1973 season, it accounted for over 50% of edible groundnut exports. It is grown mainly in the South-East where production is now 80% Runner. Exports of Virginias have declined as they are used almost entirely for the domestic edible trade following an intensive advertising campaign. Virginias are used for the relatively small quantities exported in-shell.

The quality of US nuts is below the best HPS nuts as the mechanical sorting systems are employed in such a way that they do not remove all the bad nuts and foreign matter, whereas hand-pickers can select the best of the crop. On the other hand, US nuts are more likely to be free of aflatoxin as all the crop is artificially dried soon after harvest and the system of checks, which start early in the marketing process, normally diverts affected nuts.

Exports of edible grades are also accompanied by an aflatoxin free warranty which allows rejection should the aflatoxin content of the nuts exceed 0.025 ppm $B_1+G_1+B_2+G_2$ on arrival.

Table 5

Apparent exports of edible groundnuts from the USA ('000 tonnes)

	1965	1968	1969	1970	1971	1972
Kernels		55.7	27.3	54.5	75.6	113.5
In-shell		0.3	0.2	1.1	3.4	6.1
Total (kernel equivalent)	50.0	55.9	27.4	55.3	78.0	117.8

Groundnut production is currently protected and supported under Federal legislation with the intention of safeguarding farmers' standards of living and ensuring a sufficient flow of supplies to satisfy domestic demand. If farmers elect to accept Federal assistance by voting for 'marketing quotas', production quotas and a mandatory price support system comes into operation. This is operated by a Federal agency, the Commodity Credit Corporation (CCC), which becomes a guarantor of market prices by acting as a last resort buyer at a pre-determined price level. The CCC buys the groundnut production in excess of domestic demand at support prices and sells it either for milling or for export.

Price support is based on a 'parity' price which was intended to reflect the rising costs of production. In fact, the formula used to determine the parity price has a built-in tendency to exaggerate cost increases and has given farmers a very high and increasing return relative to other crops.

Under the 1948 Act, the minimum acreage receiving support is 1,610,000 acres. This is also effectively a maximum acreage as the CCC has no desire to increase the cost of the programme.

The overall effect of the support programme has been to increase production. The restriction on acreage and the high support prices have encouraged farmers to boost their yields and provided them with the means to afford the inputs to achieve that end. This together with the larger size of farms and the high cost of labour explains the highly mechanized state of US groundnut production. Average yields have increased at 6% per year between 1959 and 1972 to reach 2,209 lbs per acre by 1972 (Kromer, 1972).

The CCC has been taking an increasing share of the crop because domestic edible consumption has grown at a slower pace than production – 3% compared with 6%. The main outlet for CCC stocks has been the domestic crushing industry, but exports have become increasingly important for both edible and crushing qualities. Export sales have responded to increased overseas demand and have been attractive, as world prices have risen, as they have shown smaller losses than sales for domestic crushing. Also they have been a source of valuable foreign exchange.

However, the cost of the support programme rose sharply in the early 1970's and was predicted to increase further as support prices escalated and as production continued to increase (Kromer, 1972).

The disposal of production was likely to fall increasily on the CCC which anticipated making larger export sales, as indicated in Table 6 below.

The Federal Government has therefore proposed a radical change in the support programme, which would in effect produce a two-tiered market and probably reduce exports. Sales for domestic edible consumption would continue to receive support, but exports and sales for milling would no longer be supported. If this system were introduced it is likely that exports would diminish significantly since growers would not find export sales profitable at pre-1973 prices. The growers

Table 6

Production and disposal of USA peanuts (in-shell) ('000 tonnes)

	1970/72 Average	1980	1985
Production	1,401	1,860	2,132
Disposal Domestic edible consumption	738	907	998
CCC stocks	578	805	964
of which Domestic Crushing	372	476	567
Exports[a]	205	329	397

(Kromer 1972)

Note: [a] In the past, about one-third of exports have been sold for milling.

have strongly opposed these proposals which would be likely to reduce farm incomes. However the upturn in world groundnut prices and the growth of domestic demand in 1973 and 1974 have produced more conciliatory attitudes. It is possible that some compromise solution will eventually be agreed which will, as a side effect, maintain exports at around current levels. In the meantime, the long-term prospects are for either a massive increase in edible exports, if the traditional support programme is maintained, or a fall in exports if the new Federal proposals are implemented and if world prices decline from the abnormally high level of 1973/74.

The normal mode of export marketing has been for the CCC to sell its stocks, which are in-shell, to US shellers, who decorticate them for sale to international dealers and foreign users. While world market prices have exceeded the support price, US shellers and growers' agents have been making export sales without the peanuts passing under the control of the CCC.

India

India is the largest producer of groundnuts, with an annual crop of between 3.5 and 6 million tonnes. Exports which are exclusively of HPS grades have varied considerably and in some years ceased altogether due to reasons explained earlier. Table 7 shows exports in recent years.

Table 7

Apparent exports of edible groundnuts from India ('000 tonnes)

	1968	1969	1970	1971	1972
Kernels	17.0	42.9	41.7	36.1	40.5
In-shell	0.6	1.5	2.0	5.0	6.4
Total (kernel equivalent)	17.4	44.0	42.1	39.6	45.0

Indian export statistics appear to under-estimate her shipments of groundnuts in total and, in particular, those to the USSR. In fact, over a third of Indian exports go to the USSR and, apparently, two-thirds go to Eastern Europe, including the USSR. It has been reported that shipments for Eastern Europe are resold before arrival. Little evidence has been found to suggest that this occurs on any scale.

India exports two types of groundnut. The commonest type are Bombay Bolds, which are Valencias and are normally offered in the count 55/60, but can be larger; the other, called Indian Javas, are a Spanish variety. Unfortunately, aflatoxin problems have been encountered on occasion with nuts from this source, although the condition of exports reputedly varies with the port of loading and, thereby, the area of production.

China

Chinese exports of groundnuts have tended to vary erratically from year to year as explained earlier. Exports at their height have represented only 2% of the annual production of over 2.5 million tonnes. Foreign trade statistics are not available, but Table 8 shows apparent exports.

Table 8

Apparent exports of edible groundnuts from China ('000 tonnes)

	1968	1969	1970	1971	1972
Shelled	49.6	40.2	11.1	13.9	39.6
In-shell	9.8	7.9	3.7	6.5	8.1
Total exports (kernel equivalent)	56.5	45.7	13.7	18.5	45.3

In the mid and late 1960's, Chinese groundnuts were especially prominent in the European edible trade, because they were the largest supply of aflatoxin-free nuts. This rôle was taken over in the 1970's by the USA due to the decline in Chinese exports. The sharp drop in exports in 1970 and 1971 may be explained by a report that the production of the large-sized HPS kernels grown for export had been shifted in 1970 to a new region because of a disease or soil fungus problem in the old producing area (Foreign Agriculture, 1970). Initially, the quality of the production from the new area was not considered as good as hitherto. However, Chinese groundnuts have retained a reputation for excellent quality. Traders do not recall any cargoes arriving contaminated with aflatoxin. They are also sought-after because they are Virginias. The kernels conform mainly to count 35/40 per ounce, although they are often exported as 'HPS no count'. Their shape is very regular.

Chinese groundnuts are auctioned at the annual Canton trade fairs and are open to bids at other times.

The Republic of South Africa

South Africa exports both milling and edible grades. HPS exports account for about 15% of the total crop. The only edible grade exported is the Common Natal, which is a Spanish type. It is graded into three sizes, 50/60, 60/70 and 70/80. In-shell groundnuts have not been exported for several years.

South Africa has emerged as a major exporter because the high quality of its HPS kernels meets the strict quality standards of certain European markets. Natals are considered in Western Europe to be of the highest quality especially regarding freedom from aflatoxin. Their reputation has been built on careful hand selection at the factory level and through pre-shipment checks by electronic sorters at Durban carried out by the Oilseeds Control Board. The South African experience shows that it is possible for a producing country with an aflatoxin problem in regard to its crops to ship aflatoxin-free products through careful selection.

Foreign trade statistics do not distinguish between million and edible grades. The Oilseeds Control Board Annual Reports show HPS exports during the crop season running from 1st July to 30th June. These figures, which are shown in Table 9, correlate reasonably with apparent exports for calendar years shown in Table 2.

Table 9

Exports of edible groundnuts from South Africa (tonnes)

1967/68	1968/69	1969/70	1971/71	1971/72
29,221	20,997	39,033	28,527	38,737

Increases in exports are limited by a growing local demand for edible groundnuts and by the proportion of groundnuts suitable for edible selection.

The trade within South Africa is controlled by the Oilseeds Control Board, although it does not physically handle stocks. Marketing of exports in the UK, the continent of Europe and Canada is conducted on its behalf by the Overseas Farmers' Co-operative Federation Ltd, London. This exclusive arrangement is subject to annual renewal, but has persisted since the 1950's. A sole selling agent has also been appointed for Hongkong. In other markets, of which the most important are Japan and New Zealand, sales are made by South African trading houses. Export prices are normally fixed at the beginning of the selling season, but they are not so inflexible that they cannot take account of changes in the market.

Nigeria

Nigeria is one of the largest exporters of groundnuts and groundnut products, but is producing groundnuts mainly for milling. Small-kernelled Virginias are the most commonly grown varietal group, but Spanish groundnuts have been introduced in an attempt to improve the stock.

In-shell groundnuts are exported only in small quantities. Edible kernels are selected from the commercial oilseed crop, but only three out of the seven processing mills select groundnuts for HPS sales. These factories purchase their groundnuts from the bulked commercial production handled by the Marketing Board. Twenty five per cent of the nuts going into these factories emerge as HPS at the start of season, declining to 15% at the end when the nuts are drier and tend to lose their skins (Nigerian Trade Journal, 1973).

All the factories employ some form of mechanical grading equipment to remove foreign matter and to sort the kernels into sizes. The final stage, to remove discoloured, shrivelled and broken kernels, is done by hand.

Exports of kernels peaked between 1968 and 1970 at over 30,000 tonnes, but have since declined to 15,000 in 1972. This has been due mainly to reduced groundnut production.

The problems of controlling the quality are accentuated by the pattern of production and marketing. Groundnuts are a cash crop grown by a large number of subsistence farmers. The average size of a holding is less than 5 acres of which no more than one acre may be given over to groundnuts (Harkness 1970). The crop is normally decorticated by the farmer, but sometimes by a middleman before being sold on to the Licensed Buying Agents of the Marketing Board. The nuts are then bulked without regard to origin, variety or edible quality. Under these conditions it is difficult to produce nuts specifically for the edible trade and impossible for the mills to purchase nuts from areas known to have minimal incidence of aflatoxin.

The outlook for groundnut production is uncertain as it has already been hit by the vagaries of the weather and farmers' reaction to the prices they obtain for their crops. However, farmers in the North, where groundnuts are mainly grown, have little choice of alternative crops and it seems likely that output will recover.

Nigerian groundnuts are marketed by the international trading houses, which are prominent in the trade of other Nigerian produce, such as cocoa. These traders may sell direct to manufacturing buyers, but more often go through intermediaries, such as national dealers.

Senegal

It is reported that Senegal is trying to expand its production of HPS groundnuts by growing specially selected varieties for the edible trade (Dimanche, 1970). Experiments started in 1963 and a Virginia type was eventually selected on yield and quality. Under the scheme supported by the Fonds Europeen de Development (FED), attention has also been paid to harvesting, processing and storage. Groundnuts, produced under this scheme, receive a considerable premium

over the price of ordinary crushing nuts. The FED scheme was originally planned to cover almost 9,000 hectares by 1972 but it has been so successful that plans were made to expand it from 1971 to cover 20,000 hectares, producing 25,000 tonnes in-shell.

Up to 1970, most of Senegal's HPS exports had been selected from the commercial oilseed crop and had been processed traditionally. It appears from the apparent exports, shown in Table 10 below, that the attempt to increase the export of edible grades has not been as successful as had been hoped. The figures up to 1970 may be on the low side, as French imports may be higher than has been allowed for due to the difficulty of differentating between edible and crushing-quality imports into France. Senegalese export statistics are not shown as they do not give full credit to the expansion in their edible trade.

Table 10

Apparent exports of edible groundnuts from Senegal ('000 tonnes)

	1968	1969	1970	1971	1972
Kernels	1.5	0.2	8.9	5.3	7.5
In-shell	0.1	0.3	1.4	1.4	0.7
Total (kernel equivalent)	1.6	0.4	9.9	6.3	8.0

Malawi

The commercial production of groundnuts in Malawi is mainly for export. Small quantities of milling grades are produced for domestic use but exports are of HPS kernels only. These are exclusively of the Chalimbana variety which produces mainly large-sized, but irregular shaped kernels.

Table 11 below shows actual exports of groundnuts from Malawi between 1968 and 1972.

Table 11

Exports of groundnuts from Malawi ('000 tonnes)

1968	1969	1970	1971	1972
30.0	34.3	22.5	29.2	35.7

Export figures for 1973 are not available, but are likely to have been substantially below the 1972 level. Early reports of the 1974 crop suggested that it might be as high as 50,000 tonnes, but initial deliveries to the buying centres have shown that kernel development was adversely affected by the heavy rains earlier in that year. The crop is now tentatively estimated at 35,000 tonnes. No long-term estimates of production have been made, but the intention is to maximise output through a major extension effort. Malawi is one of the few African countries to provide an aflatoxin guarantee with its shipments and it is reported that there has been no difficulty in keeping exports below the maximum tolerance of 0.005 ppm B_1. Each wagon load leaving the country is sampled and any lot which is shown to exceed the maximum tolerance is returned from the port of shipment for re-sampling, re-testing and re-packing where necessary. The UK has taken nearly 90% of all Malawi's exports in recent years. These sales are negotiated by the Agricultural Development and Marketing Corporation (ADMARC) under long term contracts with a few buyers in the UK. These contracts allow the quantity supplied to vary with changes in production and also leave room for some price adjustments.

Other Exporters

Accurate figures for edible groundnut exports are especially difficult to obtain for countries which are also large exporters of milling grades, such as the Sudan and the Gambia. However, it is evident from imports of edible groundnuts into the Federal Republic of Germany and Japan that the Sudan is an important supplier.

Exports consist of both kernels and in-shells and are of local varieties of Virginia and Spanish groups; Spanish nuts predominate in kernel exports. Export marketing has been made the responsibility of a governmental agency, the Sudan Oilseed Corporation. Subsequently, successful efforts have been made to improve the quality of exports, including the introduction of routine analysis for aflatoxin and the use of some electronic sorters.

In **The Gambia**, the Oilseeds Marketing Board reports that two varieties of groundnuts with low oil contents are being grown specifically for the edible trade. One, a local Virginia variety, is for sale in-shell; it has an unusually round pod containing two kernels. The other, the Philippine Pink, has been produced for confectionery use. Exports totalled around 7,000 tonnes to the season 1973/1974.

Part III

The markets for edible groundnuts

Tables 12 and 13 show imports of edible groundnuts. The notes on these tables indicate where it has been necessary to estimate imports of edible grades. The need to make estimates has arisen in three types of situations: where no import statistics are published for groundnuts, as for some East European countries; where import statistics do not differentiate between edible and milling grades, as for France; where import statistics differentiate neither between kernels and in-shell grades nor between edible and milling grades as for Spain, Japan, Switzerland and Austria.

In these cases, imports of edible grades, kernels and in-shell, have been identified from a number of different angles – by the origin from which they come, for example Israel is assumed to ship only in-shell edible nuts – by utilizing export data where it is available in sufficient detail, as in USDA export statistics and the annual report of the South African Oilseeds Control Board – through the reports of trade sources who have been interviewed, for example, the estimates for Spain were largely arrived at through information provided by international dealers – and, finally, by checking the value of imports against prices for edible and milling grades.

The estimates which have been arrived at will not be entirely accurate, inevitably, but they are believed to be of the correct order of magnitude.

Tables 12 and 13 show the main importing countries for kernels and in-shell nuts, respectively. The tables are sub-divided into major importing regions to emphasize the different patterns of consumption between the different regions. Table 14 summarises the situation for 1972.

IMPORTS OF GROUNDNUT KERNELS

Most importing countries consume more kernels than in-shells. The ratio of imports of kernels to in-shell averages 8:1 for Northern Europe and Eastern Europe and 10:1 for Canada and the Far East, but for the Mediterranean region the ratio is 1:3 in favour of in-shells.

The trade in kernels is also concentrated in a few countries, but not on a regional basis. Six countries have consistently taken 80% of all imports. They are ranked below on the basis of the tonnages they imported in 1972:

Japan	62,000 tonnes
UK	60,000 tonnes
Canada	49,000 tonnes
The Federal Republic of Germany	48,000 tonnes
The Netherlands	40,000 tonnes
The USSR	23,000 tonnes

By 1972 some of these markets appeared to be reaching saturation point. Canadian imports have stagnated since the mid-1960's and the UK's since 1969. In the Netherlands, imports were expected to level off after having grown by 4% between 1968 and 1972. In the Federal Republic of Germany, growth in imports was expected to be curtailed: after a sharp jump in 1969, they had been growing at less than 4% per annum up to 1972. Japan was the fastest growing market and imports maintained a 6% annual growth rate in the period 1968 to 1972, while the USSR's grew by 5% per annum.

In 1973 the situation changed dramatically. Imports increased at a much faster rate than in recent years. They grew by 8% in the Netherlands, 11% in Canada, 18% in the UK and 22% in Japan. These massive increases can probably be attributed to special factors stimulating demand in 1973. It should not therefore be assumed that it indicated a change in the longer term trend of a slowdown in the growth of the market and there were exceptions to the rule – the Federal Republic of Germany and the USSR.

Table 12

Edible groundnut kernels: imports into the main consuming countries ('000 tonnes)

	1968	1969	1970	1971	1972	1973
TOTAL	292.6	291.1	313.9	306.2[e]	348.8[e]	279.1[e]
of which to:						
Algeria (b)	2.6	3.2	3.8	. . .	. . .	. . .
France (b)	5.0	6.1	6.9	5.2	7.6	9.6
Italy (b)	3.9	3.5	3.4	2.4	. . .	4.0
Portugal (b)	–	–	–	–	–	–
Spain (a)	3.2	1.2	1.0	3.7	4.9	4.3
Yugoslavia (b)	–	0.6	1.4	1.4	3.1	. . .
Mediterranean Region Sub-total	13.8	14.6	16.5	19.2[e]	22.1[e]	26.4[e]
Austria (a)	0.5	0.6	0.8	0.6	0.7	1.0
Belgium/Luxembourg (b)	–	1.4	1.4	1.3	1.5	1.7
Denmark	0.2	0.8	1.0	1.2	1.2	1.3
Federal Republic of Germany	33.9	42.8	42.9	44.7	47.7	46.6
Finland (b)	1.5	1.5	0.8	0.6	0.8	0.7
Netherlands (b)	34.4	32.7	34.8	37.0	39.9	43.2
Norway (b)	1.8	1.7	1.9	2.3	3.3	2.9
Sweden (b)	0.9	1.0	0.9	0.7	1.3	1.4
Switzerland (a)	0.2	0.4	0.8	2.2	2.9	3.0
United Kingdom	55.8	58.7	59.7	48.8	59.5	70.7
Northern Europe sub-total	129.2	141.6	145.0	139.4	158.8	172.5
Bulgaria (c)	2.2	1.1	2.8	2.2	2.3	. . .
Czechoslovakia (c)	2.9	2.3	4.0	2.4	4.8	. . .
German Democratic Republic (c)	1.3	1.8	1.2	2.0	0.8	. . .
Hungary (c)	–	1.0	1.0	1.0	1.4	. . .
Poland (c)	4.2	3.7	1.7	2.7	3.1	. . .
Rumania (c)	–	–	–	0.7	1.3	. . .
USSR (a)	18.4	15.9	15.2	20.3	22.4	14.0
Eastern Europe sub-total	29.0	25.8	25.9	32.3	36.8	28.8[e]
Hong Kong (b)	10.8	9.9	10.9	8.4	8.5	9.0
Japan (a)	48.7	41.9	55.4	49.9	62.0	75.9
Singapore (b)	3.1	2.3	1.7	1.8	3.9	3.6
Malaysia (b)	7.3	6.6	5.3	3.4	. . .	. . .
Far East sub-total	69.9	60.7	73.3	63.5	79.4[e]	93.5[e]
Australia (a)	–	0.1	6.1	–	0.1	–
New Zealand (b)	2.4	4.0	3.1	2.8	3.0[e]	3.0[e]
Canada (a: 1968–1970)	48.3	44.3	44.0	49.0	49.3	54.9

Notes: . . . not available

e estimate

Sources: National Import Statistics.

These statistics do not always differentiate between edible and milling grades or between kernels and in-shell, in which case it has been necessary to estimate imports from the data provided. The key below indicates the nature of the official statistics from which the estimates were made.

Key

a. Official statistics do not differentiate between milling and edible grades or between kernels and in-shell.

b. Official statistics do not differentiate between milling and edible grades.

c. No import statistics available; imports have been estimated from export data.

Table 13

Edible groundnuts in-shell: imports into the main consuming countries ('000 tonnes)

	1968	1969	1970	1971	1972	1973
TOTAL	75.0	86.5	85.7	88.5e	96.2e	98.2e
of which to:						
Algeria	2.7	5.9	8.0	...		...
France (b)	7.0	8.4	7.7	9.4	10.8	10.5
Italy (b)	13.6	11.1	12.0	13.6	16.3	16.0
Portugal (b)	1.9	3.4	2.4	2.6	3.9	3.4
Spain (a)	10.7	18.8	15.3	20.3	19.3	20.4
Yugoslavia	0.1	1.3	0.9	2.0	2.5	
Mediterranean Region sub-total	36.0	50.2	46.3	54.9e	59.8e	59.3e
Austria (a)	1.3	1.1	1.3	1.4	1.7	1.4
Belgium/Luxembourg	0.9	0.8	0.6	0.9	0.8	0.9
Federal Republic of Germany	4.8	4.8	4.6	4.3	5.6	5.3
Netherlands	5.2	3.6	4.9	3.6	4.3	3.9
Norway	0.1	0.1	0.2	0.4	0.1	0.4
Sweden	0.1	0.1	0.2	0.4	0.1	0.2
Switzerland (a)	3.7	3.3	3.1	3.7	3.4	3.0
United Kingdom	3.5	3.5	2.7	2.1	5.3	4.7
Northern Europe sub-total	19.6	17.3	17.6	16.8	21.3	20.3
Czechoslovakia (c)	6.4	5.0	4.9	3.0	1.9	...
USSR (a)	2.2	1.9	1.9	2.0	2.0	1.0
Other East European (c)	—	0.4	0.8	0.9	0.8	...
Eastern Europe sub-total	8.6	7.3	7.6	5.9	4.7	5.7e
Hong Kong	2.6	2.5	2.5	1.8	2.2	1.5
Japan (a)	0.8	1.3	3.1	2.5	0.2	0.4
Malaysia/Singapore	4.2	2.6	3.5	3.0e	2.7e	2.0e
Far East sub-total	7.6	6.4	9.1	7.3e	3.1e	2.9e
New Zealand	0.2	0.3	0.1	0.3	...	...
Canada (a 1968–1970)	3.0	5.0	5.0	3.3	5.3	8.0

Note: The total for 1969 includes 0.1 tons for Denmark; in other years, the imports for Denmark of edible groundnuts in-shell were estimated to be below 50 tons.

Sources: National import statistics.

It has been necessary to estimate imports of edible groundnuts in three cases, and country names have been marked with the following key.

Key

a. Official import statistics do not differentiate between milling and edible grades or between groundnuts in-shell and kernels.

b. Official import statistics have included some groundnuts in-shell for milling.

c. No official import statistics available and imports have been estimated from export data.

e. estimate.

Table 14

Percentage of total imports into the major importing regions in 1972

	Kernels (%)	*In-shell (%)*
Northern Europe	45	23
Eastern Europe	11	5
Mediterranean	6	63
Far East	23	3
Canada	14	6
Others	1	–
	100	100

The smaller North European countries and countries on the Mediterranean, who have had a low level of kernel consumption, have had a faster than average increase in the imports of kernels in recent years. There is no evidence that this increase is at the expense of the growth in their in-shell markets.

Imports into Far Eastern countries other than Japan have tended to decline, while imports into Eastern Europe have stabilized. It should be noted that it is most difficult to establish accurate import statistics for East European countries. It is possible that both the Polish and the Czechoslovakian figures in Tables 12 and 13 seriously under-estimate edible imports.

Imports into the main importing countries cannot be approximated directly to consumption since there is a significant volume of re-exports of raw groundnuts and also exports of processed products, mainly salted nuts. Tables 2 and 4 show the apparent volume of re-exports, but recorded re-exports together with estimates of consumption are given in the individual market studies. In addition to the countries which are studied later, Hong Kong and Singapore have a large re-export and export trade in groundnuts and groundnut products, so that their domestic consumption may be less than half their imports.

IMPORTS OF GROUNDNUTS IN-SHELL

The Mediterranean is also the only region where in-shell imports have shown a long term upward trend. In the period 1968 to 1972 they grew by around 11% per annum. Elsewhere, in-shell consumption has been declining slowly, although in 1972 imports showed a sharp recovery in Canada and North Europe and the recovery appears to have been sustained into 1973.

CONSUMPTION PATTERNS AND PROSPECTS

The main uses for imported edible groundnuts in approximate order of importance are as follows:

(1) Roasted and salted kernels
(2) In-shell nuts
(3) Peanut butter
(4) Chocolate and sugar confectionery
(5) Bakery products

Table 15 shows imports on a per capita basis. It indicates that in a number of economically advanced countries the market has not been fully developed, although it cannot be assumed that all countries will advance to similar levels of consumption due to their different tastes and customs. For example, the highest levels of consumption are found in countries which have a high level of peanut butter consumption. The Netherlands and Canada have double the per capita consumption of other large importing countries because peanut butter accounts for 25% and 40%, respectively, of total usage compared with 5% or less in other importing countries.

Table 15

Imports of edible groundnuts (in kernel equivalent) per capita into the main importing countries (1972)

	(Kilos per capita)
Netherlands	3.22
Canada	2.43
Hong Kong	2.40
Singapore	2.05
UK	1.13
New Zealand	1.03
Norway	0.86
Federal Republic of Germany	0.84
Switzerland	0.82
Malaysia	0.60
Japan	0.59
Algeria	0.55
Spain	0.53
Czechoslovakia	0.42
Portugal	0.31
France	0.30
Italy	0.27
Austria	0.25
Denmark	0.24
Bulgaria	0.20
Belgium/Luxembourg	0.20
Finland	0.17
Sweden	0.11
USSR	0.09
Poland	0.09
Yugoslavia	0.08

These countries and the other countries which have a high level of consumption – the United Kingdom, New Zealand, the Federal Republic of Germany and Norway – consume a much higher proportion of roasted kernels than in-shell nuts; whereas countries which consume a higher proportion of in-shell nuts tend to have a lower level of consumption overall – for example, Spain, Portugal, France and Italy. This may be due in part to the sheer bulk of in-shells and the greater convenience of kernels for marketing and consumption.

The preference of the Mediterranean region for in-shells goes with a different style of living and a greater emphasis on out-of-doors entertainment and social activity. The main sites or occasions for in-shell consumption are sports arenas, beaches, evening and Sunday promenades and the cinema. It is likely that the increase in consumption, especially in Spain, is associated with the tourist boom.

In-shell consumption elsewhere tends to be concentrated into the winter months and has a limited market coverage. In Northern Europe, the Far East, Canada and New Zealand, the main market is in roasted and salted kernels. These are normally oil-roasted, but some are dry roasted. Kernels are also used unsalted in fruit and nut mixtures. Kernels are widely available and sales receive a considerable amount of promotion. Even the large in-shell markets, such as the French, are being opened up by exports from roasters in the developed markets.

The low price of groundnuts make them an attractive product and the impact of price on demand appears to be quite strong, if the experience of the UK market, which is described later, is generally applicable.

Compared with other edible nut kernels, groundnuts are very price competitive, as is illustrated in Table 16.

Table 16

Average premium for edible tree-nut kernels over the price of edible groundnut kernels in 1972 (£ per tonne)

Average Price	*Average Premium*			
Groundnuts South African 60/70s	Cashew 450's Whole	Almonds Spanish Unselected	Hazelnuts Kerrassundes	Brazils Medium Kernels
160	480	700	350	300

Sources: Gill & Duffus *Edible nut statistics; The Public Ledger*

Changes in relative prices are unlikely to be sufficiently large, given these wide differentials, to make any appreciable difference to the demand for roasted and salted kernels.

Consumers' decisions to purchase tree-nuts which are uniformly more expensive are based on a strong taste preference backed by the income to indulge it. However, the difference in price will deter most consumers from switching to tree-nuts except for special occasions. It is possible that, if real incomes continue to rise in the developed countries, the consumption of tree-nuts could increase at the expense of groundnut consumption, but only amongst high income consumers where cost becomes less important. However, the record of the major markets suggests that the groundnut and tree-nut markets are complementary rather than competitive since the development of the nut kernel eating habit assists both and both markets can grow at the same time. At the present time, the world trade in edible tree-nuts for direct consumption is about half the volume of the trade in groundnut kernels for direct consumption. In recent years, groundnuts have faced more intensive competition from other cheap savoury snacks, especially from crisps, or chips as they are called on the Continent. Some new snack lines have been achieving phenomenal growth rates and some roasters believe that this has been at the expense of growth in the groundnut market.

Another factor, which is frequently mentioned in Northern Europe to explain the stagnation in groundnut markets in recent years, is the fashion for dieting and

the greater awareness of the calorific content of foods. Groundnuts have been identified as a high calorie food and it is claimed that this is affecting adults' demand for roasted groundnuts.

The demand for peanut butter, outside the Netherlands and Canada, is very limited in importing countries and it is extremely unlikely that it will ever develop to major proportions. In the small markets, peanut butter is competing with jams, marmalade and other spreads, where tastes rather than price are important. In the high consumption markets, peanut butter is also used instead of other high protein foods, for example, in sandwiches. It certainly appears that in these countries the demand for peanut butter has been boosted by the sharp rise in the prices of other foodstuffs.

The usage of groundnut kernels in chocolate and sugar confectionery does appear to be affected by the price differential between groundnuts and edible tree-nut kernels. The example of the UK shows that as the premium for almonds has increased their usage has declined while that of cashews and groundnuts has grown. Groundnuts are unlikely to be used as a direct substitute for tree-nuts because of their strong and distinctive flavour, but new nut lines have been developed using groundnuts, which can be retailed at lower prices. The most successful of these have been chocolate coated peanuts and various chocolate-coated toffee and nut bars.

For use in bakery products, groundnut kernels are flaked as cake or biscuit decoration or crushed into large grains for use, normally with other nuts, to flavour the product.

Overall, the main determinants of demand are traditional attitudes to nuts and nut products, promotion and the price of groundnuts. In 1973, for example, consumption increases were seen in most of the major markets, because retail prices remained low while other prices rose. Intensive promotion of traditional lines exploited the cheapness of groundnuts as a protein source. It follows that demand may decline as the increase in the price of groundnuts in 1973 filters through to the retail level, which it began to do in the second half of 1974.

MARKETING SYSTEMS

A number of groundnut producing countries have centralized their export marketing in a state trading organization or marketing board rather than leaving the trade in the hands of private exporters or allowing producers to arrange their own sales. Amongst those countries which have centralised export marketing, are China, The Sudan, Malawi, Senegal, The Gambia and most of the Middle East producers. The most prominent exporters relying on a free trade system are the USA, India, Nigeria and Brazil. South Africa falls into both groups, since, for Western Europe and Hong Kong, sole agencies have been appointed, but exports to other countries are arranged by private exporters.

Some national export agencies have elected to make direct selling arrangements with users, but this is only practical where large quantities are involved. For example, Malawi sells most of its output to UK roasters on long-term contracts and South Africa trades directly with many European users through their agent in London. However, most of the trade from both national export agencies and private exporters passes through the hands of dealers in consuming countries.

These dealers fall roughly into two categories – which can be termed international and national dealers. International dealers buy from producers and sell to national dealers and large users. National dealers may buy from some selected exporting countries in addition to their purchases from international dealers; they sell on to users in their own country offering special delivery and financial terms, the nature of which are explained below. Brokers may act between exporters, dealers and users.

International dealers are in a sense fulfilling the role of selling agents and shippers for exporting countries, but they buy and sell as principals and do not act for a fixed commission. On the other side, they are in effect acting for national dealers and users as guarantors of the quality, quantity and delivery of their groundnut supplies. International dealers normally have permanent representatives in exporting countries or make regular visits at harvesting time to negotiate sales. This enables them to check the quality of shipments where guarantees are not given and offer practical advise on how quality can be improved, if necessary. This is part of the general trend towards greater collaboration between producers and consumers as quality requirements in consuming countries become stricter.

Some international dealers prefer to buy and sell on similar terms, normally cif or c and f, and they are therefore limited to selling to national dealers and large users who do not require special terms.

It is national dealers who equip themselves to offer special delivery terms, from sales ex-warehouse to delivery into the users factory, and also to finance buyers with extended payment terms. National dealers tend to buy direct from producing countries only where exporters are reliable and quality guarantees are given. For other origins they depend on international dealers. As in most commodity trades, the role of the dealer is to make compatible the desire of the producer to sell his produce, when it is available, for shipment on cif or fob terms and the wish of the user to buy, when he requires, on the most convenient delivery terms. Dealers carry stocks as a buffer between these demands and as safeguard against production shortfalls or shipment delays. These stocks often amount to two or three months supply as a dealer may be committed to a user for delivery of a particular type and origin of groundnut over several months or even a year. In Europe, the major port for the holding of stock is Rotterdam, because of its good inland communications with Northern and Eastern Europe and because of its relatively low charges. However it does not have the cool-storage facilities, at least not at economic prices, such as are used in the USA.

Brokers may act between the principals of the trade to improve communications and disseminate information. They usually receive 1% of the value of the contracts which they arrange. Brokers are most active in the trade between dealers and in the trade between exporters in the USA, Brazil and India and dealers in consuming countries. Some roasters also depend on their advice and experience to execute their buying orders. This is especially common in the Netherlands, but also occurs in other European countries. The advantages of using brokers is the wide range of their contacts, their impartiality between buyer and seller and the anonymity which principals receive during the negotiating stage.

This trade structure is normally very efficient. It has proved capable of contending with the variations in supplies from producing countries without disrupting the flow to users according to their requirements for quality and type. In particular, it has continued to move nuts from countries which can be unreliable with regard to aflatoxin into consuming countries with strict standards on aflatoxin. The trade has borne the aflatoxin risk, where insurance companies have been unwilling to do so.

The highly competitive nature of the market has kept margins to traders slim, so that exporters receive a very high proportion of the price paid by users.

The most commonly used contract for sales by dealers to users in the United Kingdom, the Netherlands and the Federal Republic of Germany is the Federation of Oil Seeds and Fats Associations contract No. 20. Copies can be obtained from the Federation's Office at 24 St. Mary Axe, London EC3A 8ER.

This section describes in greater detail the imports, consumption patterns and quality requirements of some of the leading importing countries. Official import statistics by country of origin for these and some other countries are included in Appendix II. As explained earlier, import statistics for some countries may include, without distinction, groundnuts for milling as well as edible quality groundnuts.

United Kingdom

Imports of kernels

The UK made no differentation between milling and edible grades in her foreign trade statistics and was importing groundnut kernels for both purposes up to 1970. Since then her imports have been for edible purposes only. Estimates of the milling grades suggest that imports of edible quality kernels rose from around 30,000 in the early 1960s to 46,000 tonnes in 1965 and to 56,000 tonnes in 1968 (Ministry of Agriculture, Food and Fisheries). Between 1968 and 1972, imports were in the range 55,000 to 60,000 tonnes per annum, with the exception of 1971 when they fell to 49,000 tonnes. Imports of edible groundnut kernels into the UK are shown for 1968 to 1973 in Table 17 below.

Table 17

Imports of edible groundnut kernels into the UK ('000 tonnes)

1968	1969	1970	1971	1972	1973P
55.8	58.7	59.7	48.8	59.5	70.7

Note: P—Provisional

In 1972 the main suppliers to the UK were Malawi (22,200 tonnes), Nigeria (12,100), India (6,200), South Africa (5,300), China (4,400), the USA (3,600) and Zambia (3,300).

Consumption of kernels

Estimates of the main outlets for edible groundnut kernels are shown in Table 18 below.

Table 18

Consumption of edible groundnut kernels in the UK ('000 tonnes)

	1970	1971	1972
Gross imports:	59.7	48.8	59.5
which consumed as follows			
Re-exports	2.3	1.4	3.7
Confectionery (a)	5.1	9.4	6.3
Peanut butter	2.5	3.0	3.5
Bird feeding	1.0	1.0	1.0
Roasted:			
Exports (b)	3.8	5.6	5.8
Domestic sales	35.0	35.5	42.0
Stocks	+10.0	−7.1	−2.8

Notes: a. source: Cocoa, Chocolate and Confectionery Alliance
b. may include some other nuts

The volume of groundnuts used in chocolate confectionery has varied considerably, but generally it appears to be increasing at the expense of the more expensive tree-nuts. The large variations in usage between 1970, 1971 and 1972 were probably due to the launching and promotion of new groundnut lines in 1971. The underlying steady demand for groundnuts in confectionery use comes from the main product line, chocolate coated peanuts.

Peanut butter sales were fairly static in the 1960's but responded sharply in the 1970's to consumer advertising. However, the increase in groundnut prices in 1973 and 1974, which have been reflected at the retail levels, has caused the market to mark time at 1972 levels. It is possible that the market could start to grow again with further promotion, but the size of current sales barely justifies heavy expenditure on advertising.

The consumption of roasted groundnuts increased in the mid-1960's, but appeared to have levelled off until, in April 1969, a purchase tax of 22% was imposed on salted nuts, crisps and sweet confectionery. Consumption declined in 1969 and remained static in 1970 and 1971. As a result, stocks were carried over into 1971 and imports fell by over 35% in 1971 compared with 1970. In 1972 consumption recovered to its former level and appeared to grow strongly through into 1973 when purchase tax was replaced by value added tax under which nuts were zero-rated. However, in April 1974, value added tax was imposed on confectionery, including salted nuts, at the standard rate of 10%. The impact of this tax added to the higher prices of groundnuts can be expected to inhibit demand. It appears from these experiences that demand is price sensitive. Certainly, manufacturers believe so and tend to reflect cost increases by reducing pack sizes rather than by increasing retail prices. Some believe that consumer resistance to price increases is especially strong when the unit price moves above a particular monetary unit, for example, above 5 pence for a small pack and above 10 pence for a large pack. A tax on a retail product is especially devastating because it is equivalent to an increase across all costs of production. Normally, the cost of factors of production increase independently and irregularly and are therefore easier to absorb and to introduce in the retail price without disturbing demand. For example, the imposition of a tax at 10% on the retail price is equivalent to a 25% increase in the price of groundnut kernels, assuming that the latter's cost make up 40% of the price of the final product.

The salted groundnut trade has consolidated around the large size kernels especially Malawi groundnuts. Some medium to small kernels are also salted, but the main offtake for these nuts, mainly Nigerian and South Africa Natals, are in confectionery. Natals are also used, unblanched, in fruit and nut mixtures.

In-Shell

The consumption of groundnuts in-shell continued to decline until 1972 as can be seen from Table 19 below.

Table 19

Imports of in-shell groundnuts into the UK ('000 tonnes)

1961/65	1968	1969	1970	1971	1972	1973
Average 4.1	3.5	3.5	2.7	2.1	5.3	4.6

It was expected that demand would continue to decline as the public preferred to consume shelled groundnuts. The increase in 1972 and 1973 was due to a re-direction of the marketing effort for roasted in-shells, involving the re-designing of packs and selling through supermarkets rather than the traditional outlets, such as sports meeting, street traders and small grocers. In 1972 there was no predominant supplier, but a number of countries supplied quantities within the 500 to 750 tonne range. They included the traditional suppliers, Ethiopia and Egypt, as well as relatively new suppliers, such as India, China and Brazil.

Aflatoxin

The standard for aflatoxin generally adopted by the enforcement authorities in the UK is 0.05 ppm. It should also be noted that groundnuts, like all other foodstuffs, may be rejected if, in the opinion of the authorised officer, they are unsound, unwholesome or unfit for human consumption.

Leading processors have electronic sorting machines to reduce the aflatoxin content of their processed nuts.

The Federal Republic of Germany

Imports of kernels

Imports of groundnuts for milling and 'other purposes' are shown separately in the foreign trade statistics, so an accurate assessment of edible groundnut kernel imports can be made, given the reasonable assumption that 'other purposes' are almost entirely edible use. Imports for edible purposes over recent years to 1973 are shown below.

Table 20

Imports of groundnut kernels into the Federal Republic of Germany ('000 tonnes)

1966	1968	1969	1970	1971	1972	1973
27.3	33.9	42.8	42.9	44.7	47.7	46.6

It can be seen that the sharp increase in imports in the late 1960's has been followed by slower growth in the early 1970's leading to stagnation of imports since 1972. The main supplying countries have been the Sudan, South Africa, the USA and Nigeria. Imports from the Sudan have increased dramatically and now account for around 40% of imports of edible kernels. In turn, the Federal Republic accounts for a large proportion, perhaps 80%, of the Sudan's exports of edible kernels.

Consumption of kernels

The outlets for these imports are estimated in Table 21 below; 1972 has been taken as the sample year.

Table 21

Consumption of edible groundnut kernels in the Federal Republic of Germany (1972) ('000 tonnes)

Gross imports:	48
which were consumed as follows	
Re-exports	1
Use in confectionery	5
Roasted:	
Exports[a]	10
Domestic Sales	32

Note: a exports may include some other nuts.

The main outlet for peanuts in the Federal Republic is roasted and salted peanuts. The domestic market is boosted by about 2,000 tonnes of imports mainly from Holland so that consumption is around 35,000 tonnes per annum. The market has passed out of the development stage of fast growth and has remained relatively unchanged in size over the last two years. The two most common explanations for this put forward by traders and processors are calorie consciousness and increased competition from other savoury snacks. It is suggested that the public are becoming increasing weight conscious and have identified peanuts as a high calorie food. Perhaps, more importantly, the promotion of other savoury snacks, especially crisps (or chips as they are known on the Continent), has been increased and sales are growing at the rate of 10% to 15% per annum. It appears that consumers want some variation in their snack foods and find chips a relatively cheap alternative. The main processors do not expect to see any growth in the domestic salted nut market over the next few years especially as higher cif prices will eventually be reflected at the retail level.

Some processors are making a high percentage of export sales. France is their main market, apparently taking 50% of exports with the balance going mainly to other EEC countries. As these markets develop, the turnover of some processors may continue to increase.

The success of Bahlsen's marketing of the 'pearl nut' has established the fashion in the German salted nut market for small, round nuts. At least 75% of all nuts imported are now of the Spanish variety. The preferred sizes are 60/70 and 70/80. Some large and medium size nuts are also used for salting and fruit and nut mixtures. It has been suggested that because of the high level of exports from the Federal Republic the fashion for 'pearl' nuts may spread to other markets. It is less likely that the German preference for vacuum packing retail products will influence other markets. It is estimated that in the Federal Republic 65% of groundnuts are sold in laminated film vacuum packs inside a cardboard carton, 20% in tins and 15% in flexible film bags. Vacuum packing is best suited for outlets with a slow turnover; as sales of nuts are made increasingly in supermarkets with fast turnover, the trend is towards the non-vacuum film pack, even in Germany.

There is little demand for peanut butter in the Federal Republic. Consumption is estimated at less than 50 tonnes per annum, of which the bulk is produced domestically.

The usage of groundnuts in chocolate and sugar confectionery products appears to have doubled since 1965 (Winter) and there may still be some growth in this market as new product lines, which have been popular in other countries, are being introduced. The current high price of tree-nuts is also likely to boost the usage of groundnuts in confectionery.

In-shell

Imports of in-shell groundnuts are shown in Table 22 below.

Table 22

Imports of edible groundnuts in-shell into the Federal Republic of Germany ('000 tonnes)

1968	1969	1970	1971	1972	1973
4.8	4.8	4.6	4.3	5.6	5.8

Sales of in-shells have recovered to their levels in the early 1960's after a decline in the late 1960's and early 1970's. They are expected to stay around their current level. The business is highly seasonal and is associated particularly with St. Nicholas' Day (5th December). Retail sales start in October and continue until mid-December.

The nuts are roasted, but it is important that the shells remain white; kernels should not be too small. In recent years, there has been a trend towards better quality; thus China has replaced the Sudan as the main supplier of in-shell nuts. Together they account for about 60% of imports. Other prominent suppliers are Israel and Turkey.

Aflatoxin

There is presently no law which specifically refers to aflatoxin. However, any food offered for sale must be fit for human consumption and the Governmental authorities do take products off shop shelves for testing.

Processors have, therefore, come to an understanding with traders that they will not accept a parcel with more than 0.020 ppm of aflatoxin B_1.

Most are able to reduce the aflatoxin level with the aid of electronic sorting machines or hand selection to not more than 0.005 ppm of B_1, in their final product. The market leaders, Liebelt/Bahlsen, follow a different course. They prefer to pay the premium for high quality nuts from South Africa and China which are known to be of low aflatoxin content and dispense with the cost of sorting machines.

In January 1975 legislation came into effect which forbids import of nuts with more than 0.010 ppm $B_1+B_2+G_1+G_2$ and more than 0.005 ppm B_1 alone.

The Netherlands

Imports of kernels

Not all the imports of groundnut kernels into the Netherlands are of edible quality. Small quantities are still milled. An estimate of the quantities of edible quality nuts imported between 1968 and 1973 is set out in Table 23 below.

Table 23

Imports of edible groundnut kernels into the Netherlands ('000 tonnes)

1968	1969	1970	1971	1972	1973
34.4	32.7	34.8	37.0	39.9	43.2

The choice of supplying countries has been determined for Dutch importers to a large extent by the need to obtain high quality supplies so that processors can be confident of passing the strict standard on aflatoxin imposed by the Dutch Government on retail products. However, the Dutch market has remained highly price-conscious and has retained sufficient flexibility to switch between suppliers of aflatoxin-free or guaranteed groundnuts. Thus China, the main supplier in the mid-1960's, was displaced by South Africa in the late 1960's. In the 1970's the USA's exports became competitive and it has emerged recently as the most prominent supplier. Together, these three exporting countries accounted for 75% of the Netherlands' imports of edible kernels in 1972.

Consumption of kernels

As an indication of the main outlets for edible kernels in the Netherlands, the disposal of imports in 1972 is estimated in Table 24 below:

Table 24

Disposal of edible groundnut kernel imports in the Netherlands in 1972 ('000 tonnes)

	1972
Gross imports:	40
which were consumed as follows:—	
Re-exports	5
Use in confectionery	4
Use in peanut butter	8
Roasted and salted:	
Exports[a]	4
Domestic sales	19

Note: a May include some other nuts.

The high level of re-exports from the Netherlands is not surprising in view of the importance of Rotterdam as a port for Northern and Central Europe. In addition to the sales which show up in the export statistics, a considerable volume of business for other countries passes into bonded warehouses and is not recorded.

The main difference between the edible groundnut market in the Netherlands and other European countries is the large proportion used in peanut butter. The Dutch taste for peanut butter has been explained in terms of their heavy breakfast compared with the normal Continental breakfast, but the usage extends to sandwiches and even flavouring for chips. Winter suggested in 1968 that demand for peanut butter might decline due to increasing affluence and changing life style. Traders and processors report that the demand for peanut butter has, in fact, been increasing slowly at around 3% per annum, although a major use in the chip industry had been lost in 1973 due to rising prices.

The consumption of salted groundnuts has risen to high levels in the Netherlands and is thought by roasters to be reaching saturation point. It is possible, however, that turnover may continue to grow through increased exports. At present the main export markets are the Federal Republic of Germany and France.

Salted groundnuts are sold almost exclusively in transparent packs and it is felt therefore that the appearance of the nuts is important. Large sized, regular shaped nuts are preferred, such as the Chinese, but around 50% of imports are still of the Spanish varieties. A large proportion of the Spanish nuts are South African Natals which are liked by processors because of their reliability for quality in general and aflatoxin in particular. In 1972, when around 40,000 tonnes of edible nuts were imported, it is estimated that 19,000 tonnes were small sized kernels, 14,000 tonnes medium sized and 7,000 tonnes large size. Small and medium sized nuts are used for the manufacture of peanut butter.

In-shell

Imports for 1968 to 1973 are shown in the Table 25 below.

Table 25

Imports of in-shell groundnuts into the Netherlands ('000 tonnes)

1968	1969	1970	1971	1972	1973
5.1	3.6	4.9	3.6	4.3	3.9

The main supplying country has been China, but, as with kernels, her exports, after increasing in the mid-1960's, have declined in importance. A number of other countries have increased their sales as a result. They include Madagascar, Israel, Egypt and Brazil.

Sales of in-shell groundnuts have declined slowly over the last decade. The traditional occasion for in-shell consumption was when the family sat around the dining room table on a Sunday and cracked nuts while they talked. Also school children were given a pocketful of nuts before leaving home in the morning. However, the consumption of in-shells was affected by a change in these social habits as families turned increasingly to the television for entertainment. Salted kernels were found to be more convenient and quieter than cracking in-shell nuts when television viewing.

Some processors suggest that these changes have gone full circle and that there is a reversion to the old habits so that in-shell consumption is expected to remain steady.

Aflatoxin

There is no official regulation for aflatoxin on imports, but no product sold at the retail stage may contain aflatoxin; a maximum tolerance of 0.005 ppm B_1 is allowed. In 1974 this working guideline was confirmed by legislation. It has, however, been enforced for sometime. Government Inspectors take products from shop selves for testing. If one sample is found to contain excess aflatoxin, the manufacturer of the product is liable to be fined and to have the whole production lot confiscated without compensation. The risk of incurring these heavy losses makes roasters and peanut butter processors very quality conscious in their purchases of groundnuts.

France

Imports of kernels

French foreign trade statistics do not differentiate between edible and crushing qualities of groundnuts. As France is a large importer of milling quality groundnuts, it is difficult to differentiate the quantities of edible grades. This is especially difficult for imports from countries such as Nigeria where the bulk are of milling quality. Even an arithmetic assessment of the value of imports is not

helpful in these circumstances. Therefore, the estimates for imports of edible groundnut kernels, which are set out below, are presented with less confidence than for other countries.

In addition to imports of raw kernels, a large quantity of groundnuts, which are already roasted and salted and packaged for retail sale, are imported from other EEC countries. The net inflows of these processed nuts are also included in the figures shown in Table 26. Re-exports of groundnuts have been small.

Table 26

Imports of edible groundnuts kernels into France ('000 tonnes)

	1968	1969	1970	1971	1972
Raw	5.0	6.1	6.8	8.2	7.6
Processed	2.5	3.6	4.3	5.0	7.0
Total	7.5	9.7	11.1	13.2	14.6

This table suggests that the market has doubled over the five years between 1968 and 1972. This confirms the opinions of processors who have reported rapid growth in the market. French roasters claim that their sales are increasing at an even faster rate since the revaluation of the florin and the mark in 1973, which has made imports less competitive. It is likely that the share of domestic processors will increase. As figures for raw kernel imports in Table 26 above are on the conservative side, their share may already be larger than suggested.

The main supplying countries have been China, India, the USA, Brazil and Senegal. The latter two countries have increased their share of the market significantly since 1970.

Consumption of kernels

The largest proportion of imported kernels are roasted for direct consumption. The usage in confectionery is limited due to a preference for tree-nuts, especially almonds. There appears to be no demand for peanut butter as a spread, although some may be used in bakery products.

For roasting the large size nuts are preferred and about 75% of imports appear to be of large or medium sizes.

Aflatoxin

There are no regulations concerning the aflatoxin level in imports or products. Most processors do not appear to be equipped with electronic sorting machines. However the sizeable imports from China and the USA suggest a quality consciousness in at least part of the market.

In-shell

Imports of in-shell groundnuts have continued to increase. Between 1968 and 1972, imports averaged 8,653 tonnes compared with 7,960 tonnes in the previous five years. The increase in imports has been particularly marked since 1970.

Table 27

Imports of in-shell groundnuts into France ('000 tonnes)

1968	1969	1970	1971	1972	1973
7.0	8.4	7.7	9.4	10.8	10.5

Note: Actual imports in 1973 were 15,889, but of 6,380 tons imported from the USA 5,424 tons are believed to be 'farmers' stock', which would probably be used for crushing.

The main suppliers have been Israel and Madagascar. These are generally considered to be good quality producers, but it was suggested by trade sources that only 25% of imports are of top quality grades. This suggestion that there is a

sizeable market for lower quality in shells is supported by the emergence of Brazil as a prominent supplier in the 1970's. In 1972, when 10,770 tonnes were imported Israel supplied 4,304 tonnes, Brazil 2,439 tonnes and Madagascar 1,937 tonnes.

The demand for in-shell is not concentrated in the winter period as in North European countries. The year round demand from the South of France, possibly influenced by summer sales to tourists, balances out seasonal fluctuations.

Denmark

Kernels

Imports of edible groundunts, which are shown separately from industrial groundnuts in the trade statistics, have risen steadily since 1968, as is shown in Table 28 below.

Table 28

Imports of edible groundnut kernels into Denmark (tonnes)

1962/67 Average	1968	1969	1970	1971	1972	1973
183	215	842	1,010	1,235	1,230	1,335

All imports are taken through Hamburg and are purchased free on truck from German dealers because of the problem of aflatoxin. Denmark does not permit the import of groundnuts containing any aflatoxin. It is therefore not unusual for parcels to be rejected and returned to Hamburg. The costs of delivery and re-delivery are for buyers' accounts. Despite the danger of incurring costs from a rejection, imports have continued up to 1971 to be of origins, such as Nigeria and the Sudan, which seem more likely to contain aflatoxin than, say, South African or Chinese imports, although parcels may be tested in Hamburg before delivery. In 1972 imports were almost exclusively of US peanuts. There is only one buyer in Denmark, a firm manufacturing confectionery products.

In-shell

Imports of in-shell groundnuts for edible use have not exceeded 40 tonnes since 1968. Up to 1968, in-shell groundnuts were imported in quantities in excess of 1,000 tonnes per annum, but these were low quality grades and were decorticated for milling.

Italy

Kernels

Imports of groundnuts for milling and other uses have not been differentiated in Italian import statistics since 1968. Assuming that these other uses were for human consumption, imports of edible groundnuts averaged 4,900 tonnes between 1962 and 1967. The figure for 1968 is over 90,000 tonnes and has been ignored because it cannot approximate to edible imports. Indeed the average figure for actual imports between 1962 and 1967 is higher than the estimates for 1968 to 1971 shown in Table 29 below. It is possible that these estimates are too low since they assume that no edible grades were imported from West Africa or the Sudan. The discrepancies will, however, be small since the unit value of imports from these sources tends to be below the average market price for milling grades.

Table 29

Imports of edible groundnut kernels into Italy ('000 tonnes)

Actual		Estimates			
1966	1967	1968	1969	1970	1971
3.3	3.3	3.9	3.5	3.4	2.4

In view of the uncertainty over these estimates, the only conclusion that can be drawn is that imports of edible groundnuts are at a low level. It is not possible

to say what the trend is, but trade sources do not report any noticeable increase in demand for kernels.

In-shell

The low consumption of kernels is due to a consumer preference for in-shell groundnuts.

Imports of in-shells for edible use have increased significantly since the mid-1960's. Between 1962 and 1965, imports were stable at around 5,500 tonnes per annum. Since 1966 they have grown steadily to reach an estimated 16,314 tonnes in 1972. The actual import figure for 1972 was 20,878 tonnes, but 4,500 tonnes were estimated to be U 'farmer stock', which were presumably decorticated and used for crushing. Imports of edible in-shell groundnuts between 1968 and 1973 are shown in Table 30.

Table 30

Imports of in-shell groundnuts for edible use into Italy ('000 tonnes)

1968	1969	1970	1971	1972	1973
13.6	11.1	12.0	13.6	16.3	16.0

The market is not dominated by any one supplier, but reasonable quantities are taken from a number of countries. Amongst these, the most prominent are Turkey, Israel, Syria, Egypt and Brazil. Trade sources report that about 25% of these imports are 'fancy' grades, so that most of the demand is for lower quality nuts.

Aflatoxin

The maximum tolerance on imports is 0.005 ppm of 'B_1', and imports are checked on arrival by the Public Health Department. Some lots have been rejected.

Spain

Spanish import statistics differentiate neither between edible and milling grades nor between shelled and in-shell groundnuts. A sizeable part of imports is known to be for milling.

Kernels

Trade sources confirm that Spain conforms to the typical Mediterranean pattern of edible groundnut consumption, with in-shells taking the largest part of the market. The estimates of imports of kernels below have assumed that no edible grades are imported from Nigeria, on the grounds of their low value, and that all imports from Brazil are of in-shell nuts.

Table 31

Imports of edible groundnut kernels into Spain ('000 tonnes)

1968	1969	1970	1971	1972	1973
3.2	1.2	1.0	3.7	4.9	4.7

Imports of edible kernels have been made regularly from Malawi, the USA; amongst other suppliers are Zambia and the Sudan.

In-shell

Imports of in-shell groundnuts increased dramatically during the 1960's. Winter estimated total edible annual imports between 1962 and 1965 as 2,500 tonnes, 5,500 tonnes, 7,500 tonnes and 11,000 tonnes. It now seems likely that in-shells made up three-quarters of these imports. Estimates of in-shell imports between 1968 and 1972, which are shown in the table below, suggest that imports continued to maintain a rapid growth rate up to 1971. It is likely that this growth in demand was associated with the growth in tourism during this period.

Table 32

Imports of edible groundnuts in-shell into Spain ('000 tonnes)

1968	1969	1970	1971	1972	1973
10.7	18.8	15.3	20.3	19.3	20.4

Brazil has supplied at least 80% of imports in each year, with the exception of 1964 and 1968. The Sudan is another regular supplier, while Libya has occasionally shipped large quantitites of low priced nuts. This indicates that the market is extremely price conscious and that quality requirements are relatively low.

Aflatoxin

Spain does not apply any control on the aflatoxin content of edible groundnuts.

Canada

All imports of groundnuts into Canada are for edible use. Import statistics only started to distinguish between shelled and in-shell grades in 1971 and therefore the breakdown of imports between kernels and in-shell has had to be estimated for years before 1971.

Imports of kernels

Imports of groundnut kernels into Canada are shown in Table 33 below:

Table 33

Imports of edible groundnut kernels into Canada ('000 tonnes)

1968	1969	1970	1971	1972	1973
45.5	47.8	44.0	49.0	49.3	54.9

The trend since the early 1960's has been for a growing proportion of imports to come from the USA as its export availability increased. The advantages of importing US groundnuts over off-shore supplies have been a combination of quality, price and availability. The problem of aflatoxin has emphasised the advantages. Canadian processors apply the same guidelines as the USA, which are maximum tolerances of 0.025 ppm of $B_1B_2G_1G_2$ on import and 0.020 ppm in the final product*. Parcels of US groundnuts failing to meet these tolerances can be rejected and are taken back and replaced. Off-shore supplies are much more difficult to replace, since they must be re-shipped as there is no crushing outlet or alternative use in Canada. The effect is that off-shore supplies can only be purchased from countries known to supply aflatoxin-free groundnuts such as China and South Africa, but these origins have been unable to compete with the USA on price. Furthermore, the proximity of the USA gives it advantages on speed and reliability of delivery. Purchases of US groundnuts can also be kept in cool-storage in the USA until they are required. The result has been that off-shore supplies have declined dramatically. Imports of Chinese kernels have slumped from an average of 15,500 tonnes between 1967 and 1969 to 2,100 tons between 1970 and 1973. No South African, Nigerian or Indian groundnut kernels have been imported since 1971. In 1973 the USA accounted for 96% of Canadian imports of groundnut kernels.

Consumption of kernels

Imports levelled off in the mid- and late 1960's and it was not until an intensive consumer advertising campaign started in 1971 that consumption and imports rose. The significant advance in 1973 may be associated with the sharp rise in the prices of other staple foodstuffs rather than other snacks, as over half the groundnuts imported are consumed as peanut butter.

*The Food and Drugs administration of the USA is considering whether their guideline should be replaced by a tolerance under Part 406, for poisonous and deleterious substances which cannot be avoided. The tolerance likely to be proposed to 0.015 ppm for groundnut products.

Trade sources suggest that the breakdown of consumption in 1972 in terms of groundnut kernels was as shown in Table 34.

Table 34

Consumption of edible groundnut kernels in Canada in 1972 ('000 tonnes)

Gross Imports	49.5
which were consumed as follows:	
Peanut butter	28.0
Roasting and salting	12.5
Confectionery	9.0

Peanut butter is a standard spread in Canadian households and per capita consumption is relatively high. Sales of peanut butter had been increasing slowly at the rate of 3% per annum, according to one trade estimate, until 1973 when it was promoted as a high protein food which could be used as a substitute for more expensive protein sources, such as meat. Under the current favourable market conditions, a higher growth rate was predicted and appears to have been achieved judged by the increase in imports of groundnuts in 1973.

Peanut butter is manufactured from a mixture of the Spanish type, which has a relatively high oil content, and the less oily US Runner type to achieve the required taste and oil content. US Runners are also used in confectionery, having replaced Virginias in some lines, but the large sized kernel of the Virginia variety, eg 30/32, are still preferred for salting.

As in other importing countries, the greater use of US Runners may not be associated purely with the intrinsic quality of the variety, but also because of the increased availability.

In-shell

Imports of in-shell groundnuts for which separate trade statistics are available are shown in Table 35.

Table 35

Imports of groundnuts in-shell into Canada

	1971	1972	1973
'000 tonnes	3.3	5.3	8.0

Trade sources estimate that imports of in-shell have been fairly stable at around 5,000 tonnes which suggests that consumption has risen in 1973. Imports in recent years have come mainly from China, Mexico and the USA, suggesting that the demand is increasingly for top-quality nuts.

Japan

Japan is a producer of groundnuts as well as a large importer. Domestically produced groundnuts appear to be used for direct human consumption since they are not included in the figures for the crushing of vegetable oil bearing materials, which were quoted by a representative of Japanese crushers at the Congress of the International Association of Seed Crushers held in London in 1970. Imported groundnuts have been milled in small quantities, but crushings had declined to below 1,000 tonnes in 1969.

Imports have increased as domestic production of groundnuts has declined.

Domestic production has been protected by both duties and quantitative quotas on imports. The quotas are divided between large and small size kernels; for example, the quotas in 1970 were 17,000 long tons of large size kernels and 40,000 long tons of small size kernels. Although the quotas may have restricted the natural growth of imports, they have permitted a gradual increase.

Table 36

Production and Imports of groundnuts in Japan ('000 tonnes kernel equivalent)

	1961/65 average	1966/69 average	1970/72 average
Production	97	90	82
Imports	12	40	58
Total	109	130	140

Sources: Production: FAO Production Yearbook
Imports: National Trade Statistics

It is expected that domestic groundnut production will continue to decline as the area under groundnut cultivation is being steadily reduced. The scope for increases in imports will therefore increase on a substitution basis, apart from any overall increase in the market.

The growth in the market in the 1960's and early 1970's is evident from the increase in the total availability of groundnuts shown in Table 36. The prospects for further growth is less certain since per capita consumption had reached by 1972 a level of 1.34 kilos per annum, which was relatively high by the standards of other importing countries which do not have a large peanut butter usage.

Part IV

Prices and tariffs

EDIBLE GROUNDNUT KERNELS

The trend in prices of edible groundnut kernels is illustrated in Figure I which shows the average annual price cif UK of South African Natals 60/70 since 1956.

The price of edible groundnut kernels is largely determined by the price of the milling grade of groundnuts in the world market. The main determinants of the price of the milling grades of groundnuts are the level of groundnut production and the prices of other oil seeds and fats, which can be substituted for groundnuts. Changes in groundnut production can also affect the availability of edible grades of groundnut kernels and to a certain extent the premium of edible grades, as edible groundnuts cannot be as easily substituted in the separate, edible nut market. Figure II illustrates this point. It shows that the premium for edible grades has varied inversely with groundnut production in a consistent way over the period shown, whereas the relationship of prices for milling grades and groundnut production has been less consistent.

Table 37 shows the prices of edible groundnuts of different types and sizes from various origins.

Table 37

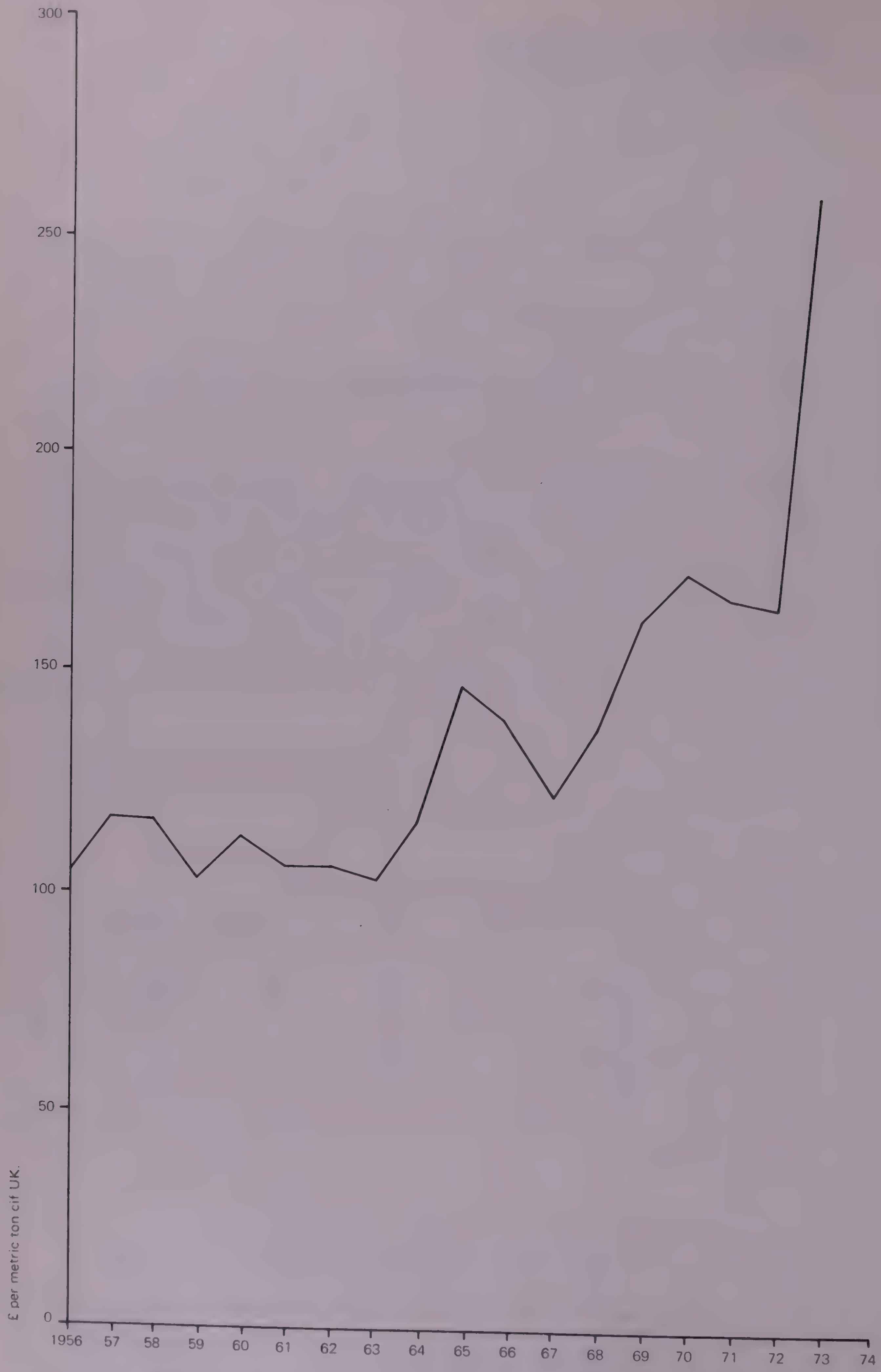
Average annual prices of edible groundnut kernels (£ per tonne cif UK)

		1968	1970	1971	1972	1973
South African Natals	60/70	135	169	163	161	–
	70/80	133	166	162	159	250
Nigerian	50/60	94	125	132	128	209
	55/65	94	125	131	127	207
Indian Bombay Bolds	55/60	–	138	140	–	–
Indian Javas	75/80	–	145	149	142	–
USA Flo Runners	40/50	–	–	–	129	–
Zambian	20/30	123	–	–	161	–

Source: The Public Ledger.

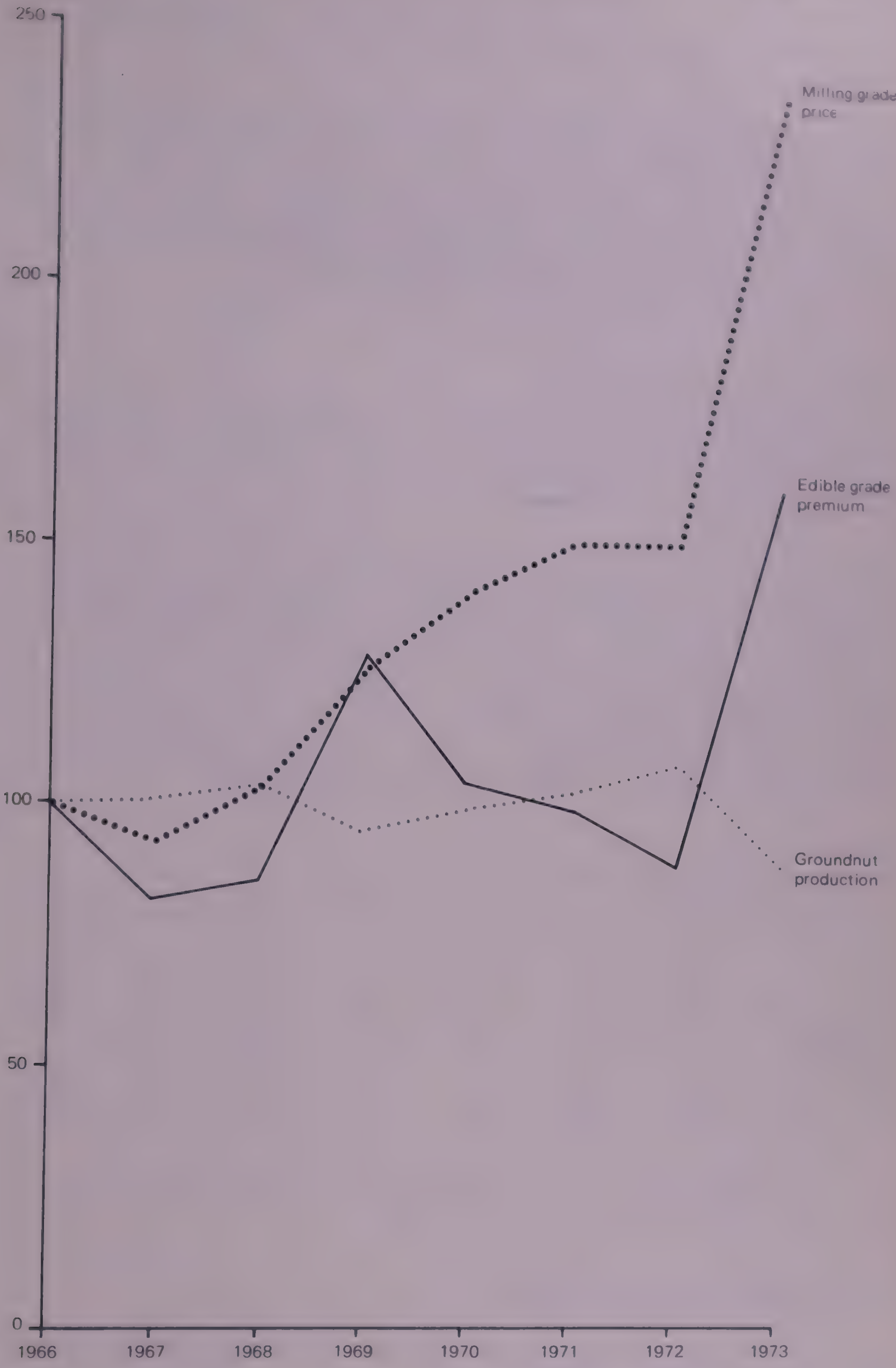
The size of the premium for edible grades also reflects varietal group. Large Virginia groundnuts receive the highest prices followed by round Spanish (eg Natals) while Valencias and Runners appear to be discounted. Although in the past, there has been a close correlation between groundnut production and the premium for edible grades it should be noted that changes in groundnut production are selective in their impact on the availability of edible groundnuts and thereby their premium. For example, small changes in the production of major exporters, such as China or India, can produce large changes in their exports and the total availability of edible grades.

Figure I
Average annual prices of edible groundnut kernels (South African Natals 60/70)



Source: *The Public Ledger*

Figure II
Comparison of world production of groundnuts, the price of milling grades and the premium for edible grades (1966 = 100)



Sources: Groundnut production: Foreign Agriculture Circular, USDA.
Groundnut prices (Nigerian milling grade and edible grade 65/75): The Public Ledger.

Where edible nuts are selected from milling grades, as in West Africa, selection has normally been considered profitable when the premium for edible grades is £25 per tonne over the price of milling grade kernels. In six out of the eight years between 1966 and 1972, the average premium for the edible grades from Nigeria was between £23 and £29 and averaged £26 per tonne. Only in 1969 and 1973 did the premium increase significantly.

The average premium for Natals 60/70 varied within the range of £56 to £73 between 1966 and 1972. In 1973, the premium widened to £83. The premiums for edible grades from other origins may vary more due to changes in their relative availability and quality, although the substitutability of different origins keeps all prices in a fairly constant relationship. For example, the premium for the superior quality of Natals 60/70 over Nigerian edible groundnuts 55/65 varied with a range of £32 to £43 throughout the period under study.

EDIBLE GROUNDNUTS IN-SHELL

There are no regular price quotations for edible groundnuts in-shell. However the average annual values per ton of imports into Italy between 1966 and 1972, which are listed in Table 38, show that they are of the same order as the prices paid for edible groundnut kernels (see Table 37).

This shows that, judging by prices realised, the market for edible groundnuts in-shell is distinct from that for groundnut kernels since, if it were not, the price for edible groundnuts in-shell would be expected to be about one third lower to account for the weight of pod. The fact that it is not, reflects the higher quality required for groundnuts in-shell which impose additional requirements in their production and generally increases the cost of production. These requirements include the need for suitable soil types (light soils) to ensure good pod characteristics, but which generally yield lower crops; specially suitable varieties which tend to be lower yielders, the need to find growing areas where aflatoxin incidence is minimal because of the difficulty of examination and selection.

Table 38

Average annual prices of edible groundnuts in-shell imported into Italy (£ per tonne)

FROM	1966	1967	1968	1969	1970	1971	1972
Turkey	132	126	148	169	170	165	185
Israel	132	123	144	161	161	153	166
Egypt	123	109	130	144	162	146	143
Syria	119	117	140	147	162	165	170
Madagascar	128	126	152	145	154	154	. . .
					(128)	(133)	(140)
Brazil	108	98	112	115	115	120	. . .
China	(127)	(119)	(142)	(159)	(170)	(186)	(161)
Sudan	108	108	114	110	118	(121)	(108)

Notes: . . . not available

Figures in brackets are the unit value of imports into the Federal Republic of Germany, which have been used where imports into Italy were nil or negligible.

TARIFFS ON EDIBLE GROUNDNUTS

A number of countries which produce as well as import groundnuts impose tariffs to protect their domestic industries.

The following are some of the tariffs imposed:

Spain — 4.5 per cent *ad valorem* General Tariff.

USA — 7 cents/lb for blanched, prepared, preserved, salted or shelled groundnuts.
4¼ cents/lb for unshelled groundnuts.

Algeria	34.40% aggregate rate (customs rates and global sole production tax)
Japan	20% *ad valorem* or 14 yen per kilo whichever is the greater.
Australia	\$0.148 per kilo General Tariff. \$0.093 per kilo British Preferential Tariff. Free Imports from Papua and New Guinea and New Zealand.

The EEC Common External Tariff came into force on 1.7.67 and it allows free entry for groundnuts. Formerly Italian producers were afforded tariff protection.

Other countries which impose tariffs are:

UK	6 per cent *ad valorem* duty as at 1.1.74 with developing Commonwealth Countries having duty-free entry.
Canada	1 per cent lb General Tariff which, however, applies to only a minority of countries since most fall with the Favoured Nations category.

The effects of these tariffs are (i) to afford some protection to domestic agricultural production in some countries, (ii) with respect to Australia, to favour Papua and New Guinea besides protecting the domestic industry and (iii) with regard to the United Kingdom, to give developing Commonwealth producers some advantage over other suppliers. However this preference will decline by stages to the Common EEC tariff by July 1977.

The USA also imposes a quota for all peanuts equivalent to 1,709,000 lbs of groundnut kernels, which effectively closes their market to foreign competition. On the other hand the Japanese quota system does not appear to have restricted a steady growth in their imports.

Part V

Conclusions and prospects

Supplies of edible groundnuts have been increasing steadily since the mid-1960's and have appeared to be sufficient overall to satisfy demand since the price premium for edible grades from the largest groundnut exporters has in most years been close to the minimum level necessary to ensure a profitable return on selection. The outlook is uncertain due to the effect of the drought in West and Central Africa, the inherent unpredictability of Indian and Chinese exports and the possibility that USA exports may increase or decrease massively depending on the outcome of the current debate on the role of Federal support to the groundnut growers.

On the demand side, there are indications that the consumption of edible groundnut kernels is reaching saturation point in the largest importing countries. The massive increases in imports in 1973 can probably be explained by a number of special factors. The increased availability of edible groundnuts coincided with a shortage of other staple foods and a surge in prices of the latter. This probably stimulated demand for groundnuts, especially in those countries with a high per capita consumption, such as the Netherlands and Canada. The same factors may also have affected demand in the UK and Japan, although in the UK the impact of a large reduction in purchase tax in 1972 may have been more important.

It may be significant that the country best insulated against inflation, the Federal Republic of Germany, did not divert from the long term trend, while the USSR's imports actually declined. It is likely that the other large importing countries will revert to a lower level of imports in 1974, especially where the higher groundnut prices have worked through to the retail level.

The exception to this rule is Japan where imports will increase while domestic production declines. The French and some other less developed markets may also continue to grow strongly, while the potential of the East European markets remains an enigma.

Imports of in-shells into the Mediterranean region countries showed no advance in 1973 over 1972 after several years of growth.

Overall, the demand for edible groundnuts will grow in the future at a slower pace, declining towards the rate of population growth in the major importing countries.

It would not be practical to project the level of edible groundnut prices since they are related to milling grade prices, which are dependent on such unpredictable factors as the size of groundnut production and the market for oilseeds and fats in general. However the premium for edible grades is unlikely to fall below the level at which selection is profitable. A massive increase in US production could undermine the premium, but this is now less likely as result of the USDA's desire to alter the support programme.

A major problem facing most less developed countries exporting edible groundnuts will be the increasingly strict quality standards imposed by major importing countries, especially with regard to freedom from aflatoxin. The tolerances for aflatoxin are becoming more uniform between countries due to official action and the requirements of the trade in processed nuts between importing countries. This presents the opportunity to those exporters capable of consistently supplying aflatoxin-free nuts of obtaining a higher premium for their groundnuts, closer to that obtained by China and South Africa. On the other hand, those exporters whose quality remains unreliable will have difficulty in disposing of the supplies and stand to lose their market share.

For exporters entering this field on a large scale for the first time, attention to quality is especially important. Importers and manufacturers will adopt a cautious attitude to new suppliers, whose groundnuts will be suspect initially on quality grounds. However, there remains an unsatisfied demand for edible groundnuts of good general quality of the large Virginia and 'pearl' Spanish varietal groups *provided they are free of aflatoxin*.

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Appendix I

Firms trading in edible groundnuts

Note: The following list gives the names of some of the firms which are known to TPI to be trading in this commodity, but the list should not be regarded as exhaustive. Inclusion in the list does not imply that TPI has any knowledge of the financial standing of the firms.

INTERNATIONAL DEALERS

Blythe, Greene Jourdain and Co Ltd
Plantation House
Fenchurch Street
London EC3

J. H. Bolland & Co
2000 Hamburg 1
Monckebergstrasse 11
Federal Republic of Germany

Gill and Duffus Ltd
23 St Dunstan's Hill
London EC3

Granadex S A
47 rue du 31 – Decembre
CH – 1211 Geneve 6
Switzerland

Internatio-Producten B V
Calandstraat 49
(PO Box 253)
Rotterdam – 3002
The Netherlands

Tracomin S A
CH – 1000 Lausanne 4
(Case Postal 45)
1 passage Perdonnet
Switzerland

Wunsche Handelsgesellschaft
2 Hamburg 11
Deichstrasse 11
Federal Republic of Germany

BROKERS

Marpro Ltd
Marshall House
14 St Mary's Road
Long Ditton
Surbiton KT6 5EZ
United Kingdom

Van Maurik
Gravenlust Buizenwerf 215
Rotterdam
The Netherlands

G De Vries and Zonen B V
Amsterdam –C
Centraal Station Oostzijde
Stationplein 9
(Postbox 498)
The Netherlands

Marcel Matalon
19 rue de Fontenay
94 Noyent-sur-Marne
France

IMPORTER/PROCESSORS

Kenyon, Son & Craven (KP Nuts)
Eastwood Trading Estate
Rotherham
Yorkshire S65 1TD
United Kingdom

Wilhelm Liebelt GmbH & Co (Bahlsen)
2 Hamburg 26
Wendenstrasse 255
Federal Republic of Germany

Appendix II

Trade statistics

Table	Country	Subject
1	Austria	Imports of groundnuts
2	Belgium–Luxembourg	Imports of groundnut kernels
3	Belgium–Luxembourg	Imports of groundnuts in shell
4	Denmark	Imports of groundnut kernels, edible
5	Denmark	Imports of groundnuts in shell
6	The Federal Republic of Germany	Imports of groundnut kernels other than for oil extraction
7	The Federal Republic of Germany	Imports of groundnuts in shell
8	Finland	Imports of groundnut kernels
9	Finland	Imports of groundnuts in shell
10	France	Imports of groundnut kernels
11	France	Imports of groundnuts in shell
12	Italy	Imports of groundnut kernels
13	Italy	Imports of groundnuts in shell
14	The Netherlands	Imports of groundnut kernels
15	The Netherlands	Imports of groundnuts in shell
16	Norway	Imports of groundnut kernels
17	Norway	Imports of groundnuts in shell
18	Portugal	Imports of groundnut kernels
19	Portugal	Imports of groundnuts in shell
20	Spain	Imports of groundnuts
21	Sweden	Imports of groundnut kernels
22	Sweden	Imports of groundnuts in shell
23	Switzerland	Imports of groundnuts not roasted
24	The United Kingdom	Imports of groundnut kernels
25	The United Kingdom	Imports of groundnuts in shell
26	Canada	Imports of groundnuts in and out of shell
27	Canada	Imports of groundnuts in shell
28	Hong Kong	Imports of groundnut kernels
29	Hong Kong	Imports of groundnuts in shell
30	Japan	Imports of groundnuts
31	Singapore	Imports of groundnut kernels
32	Singapore	Imports of groundnuts in shell
33	West Malaysia	Imports of groundnut kernels
34	West Malaysia	Imports of groundnuts in shell
35	Sarawak	Imports of groundnut kernels
36	Sarawak	Imports of groundnuts in shell
37	Australia	Imports of groundnuts
38	New Zealand	Imports of groundnut kernels
39	New Zealand	Imports of groundnuts in shell
40	Algeria	Imports of groundnut kernels
41	Algeria	Imports of groundnuts in shell
42	The USA	Exports of groundnut kernels
43	The USA	Exports of groundnuts in shell
44	The USSR	Imports of groundnuts

Table 1

Imports of groundnuts into Austria

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	2,722	1,863	1,850	2,006	1,540	1,733	1,836	1,739	2,145	2,035	2,453	2,494
	£'000	294	201	203	252	195	204	239	263	315	300	371	594
of which from:													
France	tonnes	18	22	22	18	10	–	–	–	25	20	–	–
	£'000	3	3	3	3	2	–	–	–	5	4	–	–
Federal Republic of Germany	tonnes	98	60	61	38	13	32	4	48	177	136	29	75
	£'000	18	9	9	5	2	4	1	9	28	23	6	19
Italy	tonnes	12	41	21	2	16	5	11	14	73	53	28	21
	£'000	1	3	1	–	2	1	2	2	7	7	4	6
Netherlands	tonnes	20	13	23	10	37	57	46	51	65	62	91	61
	£'000	3	2	3	2	5	8	7	9	12	12	16	15
Turkey	tonnes	149	285	289	262	232	71	139	108	171	139	14	186
	£'000	17	29	30	31	30	8	19	18	25	22	2	49
UK	tonnes	5	–	–	–	–	22	11	–	10	–	–	–
	£'000	–	–	–	–	–	1	2	–	3	–	–	–
China	tonnes	–	–	–	17	35	35	150	16	10	–	31	–
	£'000	–	–	–	2	5	4	21	4	2	–	5	–
Israel	tonnes	747	399	287	309	357	366	371	504	719	774	603	322
	£'000	99	54	38	43	49	49	51	80	105	116	98	85
Lebanon	tonnes	172	–	251	283	–	12	78	218	69	34	179	53
	£'000	21	–	29	39	–	2	12	36	11	6	29	13
Libya	tonnes	21	–	–	15	–	–	–	–	–	55	31	–
	£'000	2	–	–	2	–	–	–	–	–	8	4	–
Malawi	tonnes	–	...	...	203	64	183	146	–	–	–	–	
	£'000	–	...	...	25	7	16	13	–	–	–	–	

Table 1—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Rhodesia/Malawi/Zambia	tonnes	—	388	298	10	—	...	...	...	...	...	...	...
	£'000	—	31	27	1	—	...	...	...	...	...	...	...
Republic of South Africa	tonnes	—	...	13	36	—	—	—	—	5	40	143	219
	£'000	—	...	2	4	—	—	—	—	1	7	25	54
Nigeria	tonnes	527	1	12	130	200	236	327	505	462	397	573	649
	£'000	33	—	2	16	23	26	38	64	61	53	76	136
Sudan	tonnes	182	153	25	139	193	243	126	97	105	78	84	40
	£'000	22	17	3	18	22	29	14	14	14	10	13	8
Syria	tonnes	98	44	171	184	159	110	97	59	31	—	—	—
	£'000	12	5	22	23	21	13	15	9	5	—	—	—
Arab Republic of Egypt	tonnes	—	91	140	39	27	204	313	82	165	140	284	172
	£'000	—	10	14	5	3	23	43	13	28	21	44	40
USA	tonnes	—	—	70	35	—	—	—	—	—	11	201	287
	£'000	—	—	7	4	—	—	—	—	—	1	28	73
Brazil	tonnes	41	20	—	102	15	—	—	—	39	50	34	191
	£'000	4	1	—	11	2	—	—	—	5	7	5	45
Other Countries	tonnes	632	346	167	174	182	157	17	37	19	46	128[a]	214[b]
	£'000	59	37	13	18	22	20	1	5	3	3	16	51

Sources: *Aussenhandels Österreichs* *Österreichishes Statistisches Zentralamt*

Footnotes: . . . information not available — nil or negligible a of which 73 tonnes valued at £9,000 from Senegal b of which 100 tonnes valued at £21,000 from Senegal

Table 2

Imports of groundnut kernels into Belgium and Luxembourg

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	71,504	59,838	72,625	57,257	51,895	42,958	70,647	18,007	15,221	8,002	2,334	3,393
	£'000	4,404	3,513	4,651	3,921	3,380	2,700	4,564	1,427	1,335	842	314	660
of which from:													
France	tonnes	–	–	3,110	–	–	–	–	–	744	–	–	–
	£'000	–	–	223	–	–	–	–	–	66	–	–	–
Netherlands	tonnes	566	150	1,732	945	–	1,069	–	1,001	–	1,657	1,095	1,226
	£'000	29	9	102	53	–	76	–	108	–	189	161	248
Nigeria	tonnes	45,774	44,978	42,181	23,906	43,190	27,416	46,038	13,811	8,591	3,975	–	620
	£'000	2,832	2,650	2,671	1,691	2,855	1,733	3,002	1,064	710	391	–	107
USA	tonnes	–	–	13,174	14,671	3,797	–	–	–	–	–	837	1,024
	£'000	–	–	867	911	267	–	–	–	–	–	92	189
Sudan	tonnes	20,789	8,561	4,471	13,262	–	–	12,993	2,837	3,275	1,369	–	–
	£'000	1,251	496	287	907	–	–	793	213	283	145	–	–
Other Countries	tonnes	4,375	6,149	7,957	4,473	4,908	14,473	11,616	358	2,611	1,001	402	523
	£'000	292	358	501	359	258	891	769	42	276	117	61	116

Sources: *Commerce Extérieur* *L'Institut National de Statistique*

Footnote: – nil or negligible

Table 3

Imports of groundnuts in-shell into Belgium and Luxembourg

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	4,694	2,932	1,206	760	812	1,858	1,474	1,375	1,266	893	816	936
	£'000	310	194	104	86	98	159	166	146	143	145	143	237
of which from:													
Netherlands	tonnes	174	101	136	154	192	222	328	198	262	167	247	407
	£'000	18	10	16	21	25	26	46	27	46	24	46	101
China	tonnes	—	—	—	—	—	—	—	—	60	105	181	83
	£'000	—	—	—	—	—	—	—	—	10	18	31	18
Israel	tonnes	—	—	—	—	—	—	—	—	123	54	79	71
	£'000	—	—	—	—	—	—	—	—	23	10	15	21
Lebanon	tonnes	—	—	60	109	84	104	149	113	25	—	—	—
	£'000	—	—	7	14	11	12	21	18	4	—	—	—
Libya	tonnes	203	124	107	69	69	190	—	—	—	—	—	—
	£'000	23	14	12	8	9	14	—	—	—	—	—	—
Nigeria	tonnes	198	2,143	489	—	—	—	534	—	—	—	—	—
	£'000	120	127	30	—	—	—	37	—	—	—	—	—
Sudan	tonnes	1,552	143	100	61	94	—	123	603	—	—	—	—
	£'000	93	9	6	6	8	—	13	37	—	—	—	—
Brazil	tonnes	—	32	—	95	—	—	—	—	78	35	—	—
	£'000	—	3	—	5	—	—	—	—	9	4	—	—
Mexico	tonnes	38	30	77	113	227	231	171	68	57	260	162	—
	£'000	4	4	9	14	29	30	27	12	12	48	29	—
Arab Republic of Egypt	tonnes	—	—	—	45	—	24	—	155	—	80		
	£'000	—	—	—	4	—	3	—	19	—	12		
USA	tonnes	—	—	—	—	—	1,033	—	—	—	—	—	131
	£'000	—	—	—	—	—	64	—	—	—	—	—	40
Other Countries	tonnes	2,529	359	237	114	146	54	169	238	661	192	147	246
	£'000	52	27	24	14	16	10	22	33	39	29	22	67

Source: *Commerce Extérieur* *L'Institut National de Statistique*

Footnote: — nil or negligible

Table 4

Imports of edible groundnut kernels into Denmark

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	231	198	158	194	130	184	215	842	1,010	1,235	1,230	1,335
	£'000	16	14	16	22	14	17	26	111	139	175	222	322
of which from:													
Federal Republic of Germany	tonnes	60	3	3	8	6	–	1	1	34	–	16	43
	£'000	4	–	–	1	1	–	–	–	4	–	3	9
China	tonnes	–	–	1	14	39	47	43	4	18	267	76	189
	£'000	–	–	–	2	4	5	6	1	3	40	16	60
Indonesia	tonnes	–	–	–	23	10	10	–	5	–	–	–	–
	£'000	–	–	–	3	1	1	–	1	–	–	–	–
Nigeria	tonnes	–	1	73	5	42	58	93	208	502	625	5	289
	£'000	–	–	7	1	4	5	10	27	67	85	1	72
Rhodesia	tonnes	16	35	31	–	–	–	–	–	–	–	–	–
	£'000	1	3	3	–	–	–	–	–	–	–	–	–
Malawi	tonnes	...	...	...	4	4	10	4	4	4	–	–	–
	£'000	...	...	...	1	–	1	–	1	1	–	–	–
Zambia	tonnes	...	...	...	–	1	–	–	1	–	4	–	54
	£'000	...	...	...	–	–	–	–	–	–	1	–	15
Republic of South Africa	tonnes	36	35	31	8	11	–	21	27	41	20	39	–
	£'000	4	4	4	1	1	–	3	4	6	3	9	–
Sudan	tonnes	103	118	5	105	1	52	22	478	267	174	3	1
	£'000	6	7	–	11	–	4	2	61	35	23	1	–
USA	tonnes	–	–	5	3	–	5	30	18	–	75	1,045	757
	£'000	–	–	1	–	–	1	4	3	–	12	182	165
Other Countries	tonnes	16	6	9	24	16	2	1	96	144	70	46	2
	£'000	1	–	1	2	3	–	1	13	23	11	10	–

Sources: *Foreign Trade of Denmark* *Det Statistiske Department*

Footnotes: . . . information not available – nil or negligible

Table 5

Imports of groundnuts in-shell into Denmark

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	1,159	1,350	1,872	1,714	1,002	875	1,056	75	34	33	29	26
	£'000	69	79	114	122	66	58	78	8	5	5	6	6
of which from:													
Turkey	tonnes	—	—	—	122	—	—	—	—	—	—	—	—
	£'000	—	—	—	8	—	—	—	—	—	—	—	—
China	tonnes	—	—	—	—	—	—	10	2	9	—	—	—
	£'000	—	—	—	—	—	—	1	—	2	—	—	—
Indonesia	tonnes	—	10	—	28	186	29	10	9	—	—	—	—
	£'000	—	1	—	3	15	2	1	2	—	—	—	—
Israel	tonnes	—	—	—	—	—	—	—	—	1	6	—	—
	£'000	—	—	—	—	—	—	—	—	—	1	—	—
Nigeria	tonnes	511	505	1,045	510	15	—	13	—	—	—		—
	£'000	33	30	66	38	1	—	1	—	—	—	—	—
Ethiopia	tonnes	—	—	—	—	—	—	—	1	6	5	4	—
	£'000	—	—	—	—	—	—	—	—	1	1	1	—
Sudan	tonnes	601	826	821	970	782	840	1,016	56	10	14	7	16
	£'000	32	47	47	66	49	56	73	5	1	2	1	4
Other Countries	tonnes	47	9	6	84	19	6	7	7	8	8	18	10
	£'000	4	1	1	7	1	—	2	1	1	1	4	2

Sources: *Foreign Trade of Denmark* *Det Statistiske Department*

Footnote: — nil or negligible

Table 6

Imports into the Federal Republic of Germany of groundnut kernels, other than those for oil extraction

		1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	26,884	30,671	33,907	42,837	42,886	44,658	47,725	46,568
	£'000	2,939	2,985	3,395	5,110	5,535	6,001	6,508	8,864
of which from:									
Netherlands	tonnes	730	603	547	651	722	775	1,197	915
	£'000	83	66	63	82	98	112	172	207
Spain	tonnes	12	206	–	–	–	–	47	–
	£'000	1	22	–	–	–	–	7	–
China	tonnes	4,135	1,252	812	235	42	208	809	1,052
	£'000	470	122	92	31	7	38	120	205
India	tonnes	124	–	968	3,193	2,732	1,652	1,464	68
	£'000	13	–	110	399	375	233	211	13
Indonesia	tonnes	199	20	79	202	–	106	–	–
	£'000	17	2	9	21	–	15	–	–
Angola	tonnes	82	–	–	20	352	–	–	–
	£'000	9	–	–	2	42	–	–	–
Gambia	tonnes	64	–	–	321	707	260	–	672
	£'000	5	–	–	35	76	33	–	141
Kenya	tonnes	239	36	–	35	47	221	80	55
	£'000	21	2	–	4	6	27	10	10
Malawi	tonnes	88	510	2,647	549	493	210	257	290
	£'000	10	45	267	71	73	28	34	59
Mali	tonnes	–	–	–	–	–	70	–	–
	£'000	–	–	–	–	–	9	–	–
Mozambique	tonnes	–	–	–	112	–	–	–	144
	£'000	–	–	–	13	–	–	–	32

Table 6—continued

		1966	1967	1968	1969	1970	1971	1972	1973
Nigeria	tonnes	6,085	6,564	4,336	6,585	7,561	5,898	603	4,618
	£'000	572	556	356	615	793	709	74	991
Republic of South Africa	tonnes	6,222	7,777	8,195	9,178	12,263	11,962	10,631	11,535
	£'000	776	869	892	1,249	1,850	1,852	1,647	2,134
Senegal	tonnes	–	49	–	105	616	582	785	826
	£'000	–	4	–	13	87	77	114	172
Sudan	tonnes	4,104	6,801	9,206	17,853	15,776	19,120	20,123	17,972
	£'000	399	581	778	1,971	1,896	2,376	2,587	2,952
Tanzania	tonnes	239	280	151	73	–	40	–	–
	£'000	17	19	11	5	–	4	–	–
Zambia	tonnes	74	–	–	14	–	51	–	–
	£'000	7	–	–	3	–	7	–	–
Arab Republic of Egypt	tonnes	55	–	–	16	86	783	106	–
	£'000	6	–	–	2	13	99	14	–
Brazil	tonnes	124	–	–	115	854	744	154	1,122
	£'000	12	–	–	11	117	92	18	224
Canada	tonnes	–	–	–	–	–	331	233	297
	£'000	–	–	–	–	–	48	30	46
USA	tonnes	4,636	6,830	7,458	3,519	473	1,501	10,600	6,729
	£'000	512	676	812	577	85	220	1,398	1,612
Other Countries	tonnes	328	257	492	61	162	144	636	273
	£'000	9	21	5	6	17	22	72	66

Sources: *Der Aussenhandel* *Statistisches Bundesamt*

Footnote: – nil or negligible

Table 7

Imports into the Federal Republic of Germany of groundnuts in-shell

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	7,759	5,469	4,055	5,571	5,051	3,902	4,849	4,818	4,557	4,282	5,620	5,848
	£'000	697	506	391	558	501	382	537	596	574	650	822	1,239
of which from:													
Turkey	tonnes	169	274	–	–	76	–	23	59	53	189	156	567
	£'000	18	31	–	–	9	–	4	10	9	32	30	152
China	tonnes	25	–	215	190	411	1,012	1,003	1,079	353	1,046	2,388	1,945
	£'000	3	–	24	24	52	120	142	171	60	195	385	390
India	tonnes	75	202	60	30	–	–	16	–	45	48	–	49
	£'000	7	16	5	3	–	–	2	–	5	7	–	10
Indonesia	tonnes	25	–	–	–	–	16	–	–	–	–	–	–
	£'000	2	–	–	–	–	1	–	–	–	–	–	–
Israel	tonnes	415	240	193	315	144	113	322	306	505	550	451	458
	£'000	50	31	25	40	17	13	41	40	81	92	80	125
Lebanon	tonnes	74	252	429	462	223	37	98	116	141	–	47	46
	£'000	8	28	47	53	27	4	15	17	23	–	6	11
Taiwan	tonnes	–	–	–	10	63	25	41	43	–	–	29	–
	£'000	–	–	–	2	8	3	6	7	–	–	5	–
Arab Republic of Egypt	tonnes	385	352	282	313	200	469	537	336	569	470	397	110
	£'000	45	40	31	36	25	52	73	51	94	73	66	28
Libya	tonnes	612	272	375	63	64	242	121	–	–	31	–	–
	£'000	70	30	41	8	9	20	9	–	–	4	–	–
Gambia	tonnes	25	–	–	–	–	–	–	–	–	–	202	129
	£'000	3	–	–	–	–	–	–	–	–	–	24	20
Nigeria	tonnes	–	151	–	49	109	55	–	59	–	–	–	84
	£'000	–	12	–	4	10	5	–	6	–	–	–	19

Table 7—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Senegal	tonnes	–	–	–	–	–	–	–	–	–	65	–	–
	£'000	–	–	–	–	–	–	–	–	–	9	–	–
Sudan	tonnes	4,952	3,045	2,144	3,538	3,532	1,713	2,413	2,605	2,600	1,651	1,579	1,655
	£'000	380	246	180	320	317	138	210	254	258	200	170	293
Syria	tonnes	576	371	263	159	127	47	31	122	26	100	80	154
	£'000	64	40	29	19	17	6	5	19	5	17	14	41
Brazil	tonnes	–	–	–	25	–	–	–	25	127	–	–	148
	£'000	–	–	–	3	–	–	–	2	17	–	–	28
Mexico	tonnes	251	156	35	274	93	89	62	18	69	79	72	45
	£'000	26	18	4	30	9	11	10	3	13	14	13	13
USA	tonnes	–	–	–	–	–	51	174	46	–	–	48	245
	£'000	–	–	–	–	–	5	20	16	–	–	6	60
Other Countries	tonnes	175	154	59	143	9	33	8	4	69	118	171	213
	£'000	21	14	5	16	1	4	–	–	9	16	23	49

Sources: *Der Aussenhandel* *Statistisches Bundesamt*

Footnote: — nil or negligible

Table 8

Imports of groundut kernels into Finland

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	1,682	1,332	691	688	752	823	1,544	1,489	804	621	764	713
	£'000	134	106	79	91	99	97	169	182	126	102	134	152
of which from:													
Federal Republic of Germany	tonnes	4	6	20	11	20	7	10	3	8	27	–	19
	£'000	1	1	3	2	3	1	2	1	2	6	–	6
Netherlands	tonnes	9	5	60	32	47	73	73	71	60	35	47	40
	£'000	1	1	8	5	7	10	11	12	10	7	10	11
Sweden	tonnes	–	17	23	20	23	9	5	6	1	2	–	1
	£'000	–	3	4	4	4	2	1	1	–	–	–	–
UK	tonnes	–	–	3	–	6	–	–	18	5	5	–	–
	£'000	–	–	1	–	1	–	–	1	1	1	–	–
China	tonnes	–	–	–	30	109	144	74	–	–	206	501	308
	£'000	–	–	–	4	14	18	11	–	–	32	81	53
India	tonnes	–	–	59	–	–	–	62	–	33	–	23	18
	£'000	–	–	6	–	–	–	9	–	5	–	4	3
Indonesia	tonnes	–	–	–	10	–	–	–	186	10	–	–	–
	£'000	–	–	–	1	–	–	–	28	2	–	–	–
Malawi	tonnes	...	...	...	152	232	80	126	6	2	–	–	–
	£'000	...	...	...	20	30	10	17	1	–	–	–	–
Nigeria	tonnes	1,022	508	–	–	–	2	680	512	6	21	–	26
	£'000	69	29	–	–	–	–	55	36	1	3	–	7
Rhodesia/Malawi/Zambia	tonnes	445	383	176	12[a]	–	10[a]	–	–	–	–	–	–
	£'000	40	27	18	1	–	1	–	–	–	–	–	–
Republic of South Africa	tonnes	117	380	289	342	274	444	483	621	677	293	143	156
	£'000	13	41	32	43	35	49	59	90	104	47	29	30
Zambia	tonnes	...	...	...	2	–	20	16	–	–	–	–	–
	£'000	...	...	...	–	–	2	2	–	–	–	–	–
USA	tonnes	–	–	36	22	9	1	1	–	–	20	9	–
	£'000	–	–	4	2	1	–	–	–	–	3	2	–
Other Countries	tonnes	85	33	25	55	32	33	14	66	2	12	41	145
	£'000	10	4	3	9	4	4	2	12	1	3	8	42

Source: *Foreign Trade* *Official Statistics of Finland*

Footnotes: – nil or negligible ... information not available a Rhodesia

Table 9

Imports of groundnuts in-shell into Finland

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	584	64	594	726	1,058	549	737	534	2,335	4	62	58
	£'000	43	7	42	62	78	35	45	51	226	1	11	9
of which from:													
Madagascar	tonnes	–	–	–	1	17	2	–	–	–	–	–	–
	£'000	–	–	–	–	3	–	–	–	–	–	–	–
Nigeria	tonnes	–	–	510	513	1,021	508	–	2	2,302	–	–	10
	£'000	–	–	32	40	73	30	–	–	221	–	–	3
Rhodesia/Malawi/Zambia	tonnes	–	–	30	23[a]	8[a]	10[a]	–	–	–	–	–	2
	£'000	–	–	3	3	1	1	–	–	–	–	–	
Republic of South Africa	tonnes	–	23	23	38	–	18	19	–	10	3	1	1
	£'000	–	3	3	5	–	2	2	–	2	1	–	
Sudan	tonnes	481	–	2	10	5	–	715	6	–	–	8	11
	£'000	31	–	–	2	1	–	42	1	–	–	1	2
Other Countries	tonnes	103	41	29	141	7	11	3	526	23	1	53[b]	33[c]
	£'000	12	4	4	12	–	2	1	50	3	–	10	4

Source: *Foreign Trade* *Official Statistics of Finland*

Footnotes: – nil or negligible a Malawi b of which 50 tonnes valued at £9,000 from China c of which 31 tonnes valued at £3,000 from Brazil

Table 10

Imports of groundnut kernels into France

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	453,823	526,895	431,448	499,394	533,370	516,758	508,490	467,283	309,032	217,881	137,915	231,748
	£'000	33,157	37,107	31,559	34,714	37,294	35,472	33,531	37,812	27,783	21,861	14,018	36,393
of which from:													
Belgium/Luxembourg	tonnes	–	–	–	–	–	–	–	–	50	1,106	–	–
	£'000	–	–	–	–	–	–	–	–	5	117	–	–
Netherlands	tonnes	–	–	–	–	–	–	–	–	–	723	–	–
	£'000	–	–	–	–	–	–	–	–	–	75	–	–
China	tonnes	105	–	647	1,067	1,804	2,061	2,033	1,547	1,047	1,478	2,222	2,102
	£'000	11	–	62	119	216	216	247	212	168	268	329	470
India	tonnes	–	–	173	357	–	45	411	1,683	2,044	849	–	–
	£'000	–	–	18	43	–	5	45	220	295	121	–	–
Indonesia	tonnes	–	–	–	–	–	–	–	186	458	90	–	–
	£'000	–	–	–	–	–	–	–	26	45	11	–	–
Israel	tonnes	–	–	–	–	49	–	175	–	–	177	73	–
	£'000	–	–	–	–	7	–	30	–	–	24	11	–
Algeria	tonnes	–	–	–	–	–	–	–	–	1,074	–	–	–
	£'000	–	–	–	–	–	–	–	–	93	–	–	–
Cameroon	tonnes	6,914	15,081	13,628	5,981	4,579	9,170	1,000	9,491	9,160	4,079	1,781	11,104
	£'000	531	1,092	1,014	427	320	639	67	754	810	419	181	2,017
Central African Republic	tonnes	–	292	1,914	1,554	–	–	–	–	–	–	–	–
	£'000	–	22	142	110	–	–	–	–	–	–	–	–
Chad	tonnes	263	1,772	2,530	317	–	–	–	–	–	–	–	–
	£'000	20	123	191	22	–	–	–	–	–	–	–	–
Dahomey	tonnes	6,356	9,225	4,227	425	1,523	3,507	8,226	6,356	3,442	1,056	2,141	975
	£'000	480	673	313	30	106	254	540	477	300	106	205	156
Gambia	tonnes	–	–	–	–	–	–	4,758	12,586	5,123	501	2,568	7,453
	£'000	–	–	–	–	–	–	310	918	449	53	255	857
Ivory Coast	tonnes	–	–	–	396	1,851	–	340	–	–	–	–	1,315
	£'000	–	–	–	25	131	–	22	–	–	–	–	212
Kenya	tonnes	229	–	121	–	–	–	–	–	–	50	76	–
	£'000	26	–	8	–	–	–	–	–	–	6	10	–

Table 10—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Madagascar	tonnes	58	108	71	92	40	–	84	108	32	–	–	–
	£'000	6	10	7	10	5	–	10	12	4	–	–	–
Malawi	tonnes	2,128[a]	2,974[a]	1,689[a]	346	157	327	723	46	–	–	–	–
	£'000	174	233	152	39	17	27	65	7	–	–	–	–
Mali	tonnes	8,204	19,665	3,701	787	–	1,683	1,532	–	6,395	5,648	11,909	1,143
	£'000	612	1,452	244	52	–	112	126	–	582	576	1,182	169
Niger	tonnes	62,671	78,515	90,450	81,055	98,074	155,175	137,981	134,095	88,349	76,573	40,111	25,405
	£'000	4,809	5,991	6,793	5,787	6,949	10,957	9,266	10,847	7,818	7,229	3,918	4,221
Nigeria	tonnes	62,021	186,867	105,891	168,812	174,158	158,029	165,799	214,798	117,410	54,690	29,768	74,329
	£'000	3,703	11,366	6,864	12,100	11,864	10,264	10,823	17,935	10,385	5,418	3,000	12,299
Senegal	tonnes	287,152	197,283	187,024	200,859	221,992	145,524	151,069	66,678	43,866	22,336[a]	1,951	1,474
	£'000	21,641	15,156	14,348	13,244	15,572	10,227	9,697	4,871	3,913	2,417	266	288
Republic of South Africa	tonnes	8,124	–	565	–	–	582	1,375	341	16,605	13,529	9,762	10,864
	£'000	502	–	38	–	–	37	97	38	1,568	1,419	1,005	1,694
Sudan	tonnes	5,627	7,430	11,125	24,296	15,833	32,435	20,339	9,190	4,754	24,912	23,353	66,465
	£'000	346	403	776	1,696	1,122	2,128	1,254	629	427	2,385	2,237	9,201
Tanzania	tonnes	–	372	267	70	–	589	–	–	–	–	–	–
	£'000	–	28	22	6	–	35	–	–	–	–	–	–
Togo	tonnes	1,222	2,896	2,800	2,056	3,255	2,983	6,500	3,984	3,138	2,750	1,035	–
	£'000	91	212	202	144	216	209	433	312	197	275	100	–
Uganda	tonnes	–	–	–	–	482	107	–	–	–	–	–	–
	£'000	–	–	–	–	32	7	–	–	–	–	–	–
Upper Volta	tonnes	1,115	3,370	3,547	3,086	3,919	3,340	4,170	3,989	3,265	2,400	2,868	5,749
	£'000	85	260	273	222	274	233	281	303	274	260	290	939
Brazil	tonnes	632	878	76	888	400	207	105	812	1,782	1,347	1,380	2,012
	£'000	53	69	5	86	38	19	12	93	204	164	172	405
USA	tonnes	–	–	430	6,239	4,262	875	1,757	681	186	2,949	6,231	17,884
	£'000	–	–	33	487	346	89	191	80	34	424	782	2,976
Other Countries	tonnes	1,002	167	572	711	992	119	113	712	852	638	686	3,474[b]
	£'000	67	17	54	65	79	14	15	78	212	94	75	489

Source: *Commérce Exterieur* *Direction Général des Douanes et Droits Indirectes*

Footnotes: – nil or negligible a Includes Rhodesia and Malawi b of which 2,647 tonnes valued at £299,000 from Zambia

Table 11

Imports of groundnuts in-shell into France

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	7,622	9,539	8,392	6,928	7,909	7,031	6,961	8,430	7,681	9,425	10,770	15,892
	£'000	828	953	875	840	1,011	838	976	1,227	1,166	1,374	1,681	2,926
of which from:													
China	tonnes	–	–	156	62	481	197	435	127	154	44	354	45
	£'000	–	–	17	8	63	22	60	19	26	5	61	...
Israel	tonnes	1,883	1,373	1,435	1,533	1,732	1,807	2,313	2,580	2,316	2,886	4,304	4,044
	£'000	269	205	208	216	255	258	385	463	437	531	793	1,009
Lebanon	tonnes	378	220	330	46	126	84	121	204	172	222	68	89
	£'000	42	24	35	5	16	9	18	32	27	34	11	20
Syria	tonnes	–	–	433	353	277	258	450	418	405	201	73	279
	£'000	–	–	45	44	37	33	62	59	67	31	12	62
Congo Peoples Republic	tonnes	186	301	110	184	–	–	157	–	–	–	–	–
	£'000	20	28	10	19	–	–	17	–	–	–	–	–
Ethiopia	tonnes	54	–	365	59	–	–	78	378	49	39	82	73
	£'000	5	–	34	6	–	–	7	41	6	5	11	...
Madagascar	tonnes	3,419	4,649	4,746	4,069	3,291	3,486	2,905	2,940	2,197	2,660	1,937	1,730
	£'000	350	448	466	470	415	397	368	371	282	354	272	322
USA	tonnes	–	1,016	–	–	–	–	–	–	–	516	274	6,380
	£'000	–	64	–	–	–	–	–	–	–	78	45	886
Senegal	tonnes	–	–	–	–	91	343	78	277	260	1,258	263	265
	£'000	–	–	–	–	10	42	10	40	41	122	43	55
Sudan	tonnes	989	646	512	–	279	141	58	–	–	–	495	30
	£'000	73	41	30	–	26	10	5	–	–	–	48	...
Arab Republic of Egypt	tonnes	–	377	–	137	132	78	169	440	297	178	455	369
	£'000	–	41	–	16	17	9	21	73	51	32	75	82
Brazil	tonnes	281	59	–	144	718	317	69	843	1,506	1,307	2,439	2,197
	£'000	24	5	–	15	74	31	8	102	187	161	307	373
Mexico	tonnes	147	654	63	147	483	29	–	–	215	–	–	–
	£'000	17	79	8	19	62	4	–	–	37	–	–	–
Other Countries	tonnes	285	244	242	194	299	291	128	223	110	114	26	391
	£'000	28	18	22	22	36	23	15	27	5	21	3	117

Source: *Commerce Extérieur* *Direction Générale des Douanes et Droits Indirectes*

Footnote: – nil or negligible ... information not available

Table 12

Imports of groundnut kernels into Italy

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972[a]	1973[a]
FOR EDIBLE OIL	tonnes	15,448	32,530	35,203	35,500	73,156	119,950	72,554	...	...	...	...	...
	£'000	923	1,929	2,134	2,489	5,086	7,762	4,729	...	...	...	...	...
FOR INDUSTRIAL OIL	tonnes	53,788	135,708	87,583	56,436	72,857	4,295	150	...	...	...	...	...
	£'000	3,198	8,024	5,341	3,991	4,945	289	12	...	...	...	...	...
OTHER THAN FOR OIL	tonnes	7,992	5,125	3,394	6,269	3,263	3,344	91,401	...	...	...	...	...
	£'000	522	369	297	571	347	297	5,911	...	...	...	...	...
TOTALS	tonnes	77,228	173,363	126,180	98,205	49,276	127,589	164,105	104,084	108,468	95,171	91,078	83,149
	£'000	4,643	10,322	7,772	7,051	10,378	8,348	10,652	7,879	8,970	8,816	9,117	11,422
of which from:													
Iceland	tonnes	–	–	–	912	–	–	–	–	–	–		
	£'000	–	–	–	68	–	–	–	–	–	–		
France	tonnes	27	6	6	34	160	45	10	141	86	–		
	£'000	4	1	1	5	15	7	2	27	18	–		
Netherlands	tonnes	–	3	33	16	1	39	13	13	51	–		
	£'000	–	1	3	2	–	3	1	2	8	–		
Norway	tonnes	–	–	–	1,016	–	–	–	–	–	–		
	£'000	–	–	–	72	–	–	–	–	–	–		
UK	tonnes	11	–	520	89	1	–	–	–	–	–		
	£'000	1	–	33	10	–	–	–	–	–	–		
Czechoslovakia	tonnes	–	–	–	–	–	–	–	–	1,000	–		
	£'000	–	–	–	–	–	–	–	–	74			
China	tonnes	25	56	742	605	530	387	333	–	–	50		
	£'000	2	5	41	59	63	40	35	–	–	9		
India	tonnes	114	75	111	–	–	–	299	557	578	84		
	£'000	11	7	10	–	–	–	38	72	77	11		
Angola	tonnes	993	–	231	487	679	141	–	26	–	–		
	£'000	60	–	19	47	68	12	–	3	–			
Arab Republic of Egypt	tonnes	–	–	–	15	19	–	–	2,097	1,533	4,169		
	£'000	–	–	–	2	2	–	–	174	127	372		

Table 12—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972[a]	1973[a]
Cameroon	tonnes	—	—	2,036	4,570	1,706	—	493	1,411	501	516	...	...
	£'000	—	—	128	323	121	—	33	114	42	50	...	...
Dahomey/Senegal/Mali	tonnes	—	2,133	—	9,801	16,514	19,603	25,311	13,597	13,776	15,251	...	...
	£'000	—	128	—	697	1,120	1,296	1,579	1,081	1,122	1,540	...	...
Gambia	tonnes	30,465	34,251	27,040	11,896	12,937	6,966	2,417	5,769	2,794	5,017	12,147	3,748
	£'000	1,835	1,994	1,680	855	888	476	160	417	249	427	1,212	538
Kenya/Uganda/Tanzania	tonnes	383	413	411	203	91	468	—	105	20	—	...	...
	£'000	24	26	36	20	10	32	—	12	3	—	...	...
Niger	tonnes	305	—	—	—	5,788	10,997	18,541	5,982	28,882	4,863	9,914	...
	£'000	18	—	—	—	406	772	1,192	451	2,268	459	994	...
Nigeria	tonnes	32,169	81,260	42,548	47,253	88,819	68,997	99,923	67,007	50,348	20,920	12,706	30,248
	£'000	1,913	4,914	2,626	3,383	6,139	4,341	6,438	4,811	4,130	1,905	1,277	4,244
Malawi/Rhodesia	tonnes	2,645	14,406	1,567	1,026	1,642	9,153	2,190	688	218	—	...	...
	£'000	191	892	140	106	138	619	199	79	32	—	...	...
Republic of South Africa	tonnes	70	12,955	12,276	89	26	2,055	3,821	36	65	39	...	...
	£'000	6	769	735	11	4	134	257	5	10	6	...	...
Sudan	tonnes	9,681	25,254	35,373	17,590	17,671	7,915	8,120	3,140	3,292	21,246	17,468	20,177
	£'000	554	1,460	2,156	1,181	1,187	521	505	277	274	1,867	1,689	2,298
Togo	tonnes	—	—	—	—	—	—	—	1,000	1,498	1,214	...	...
	£'000	—	—	—	—	—	—	—	86	120	116	...	...
Upper Volta	tonnes	—	—	—	1,000	384	554	794	1,220	903	4,829	...	...
	£'000	—	—	—	73	26	37	59	109	73	481	...	...
Zambia	tonnes	—	—	—	10	977	5	107	256	394	429	...	...
	£'000	—	—	—	1	66	1	13	34	56	61	...	...
Brazil	tonnes	30	46	1	815	566	202	127	799	1,969	999	...	3,100
	£'000	3	4	—	87	58	20	16	96	235	122	...	524
USA	tonnes	—	1,598	2,068	559	57	11	51	—	—	15,033	24,591	15,013
	£'000	—	61	82	29	7	1	6	—	—	1,323	2,423	1,944
Other Countries	tonnes	310	907	1,217	219	708	51	1,555	240	560	512	14,252	10,863
	£'000	21	60	82	20	60	36	119	29	52	67	1,522	1,874

Source: *Commercio con L'Estero* *Instituto Centrale di Statistica*

Footnotes: — nil or negligible ... information not available a Subject to amendment

Table 13

Imports of groundnuts in-shell into Italy

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972[a]	1973[a]
FOR EDIBLE OIL	tonnes	...	...	...	–	6,588	–	...	...	...	...	...	
	£'000	...	...	...	–	471	–	...	...	...	...	...	...
FOR INDUSTRIAL OIL	tonnes	...	...	...	–	246	20	...	...	...	...		
	£'000	...	...	...	–	18	4	...	...	...	...		
OTHER THAN FOR OIL	tonnes	...	...	...	4,746	7,219	8,390	...	...	...	...		
	£'000	...	...	...	501	827	939	...	...	...	...	...	...
TOTALS	tonnes	5,313	5,995	5,832	4,746	14,053	8,410	13,585	11,056	12,024	13,589	20,878	15,953
	£'000	502	547	550	501	1,316	943	1,807	1,526	1,730	2,028	2,936	3,425
of which from:													
Turkey	tonnes	148	333	176	64	1,082	1,584	1,113	1,143	2,030	4,542	4,043	5,356
	£'000	15	32	16	7	143	200	165	193	345	748	749	1,250
India	tonnes	–	–	–	–	–	16	–	30	–	–		
	£'000	–	–	–	–	–	2	–	4	–	–		
Israel	tonnes	102	58	35	64	151	676	748	339	553	2,035	2,324	1,422
	£'000	12	7	4	8	20	83	108	50	89	311	386	313
China	tonnes	–	–	–	–	117	–	86	115	55	–		
	£'000	–	–	–	–	14	–	14	17	9	–		
Lebanon	tonnes	29	43	123	667	885	359	768	713	772	326		
	£'000	3	5	14	86	115	39	105	100	115	48		
Ethiopia	tonnes	2,155	3,142	1,747	2,056	652	294	279	248	29	331		
	£'000	189	262	149	208	77	28	27	28	4	35		
Libya	tonnes	2,021	1,806	2,981	448	223	370	4,169	815	62	836		
	£'000	220	187	302	47	29	38	564	87	7	112		
Madagascar	tonnes	87	–	–	83	257	261	79	152	104	253	...	1,314
	£'000	9	–	–	11	33	33	12	22	16	39	...	300

Table 13—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972[a]	1973[a]
Nigeria	tonnes	—	—	—	—	5,018	—	51	—	—	—	. . .	. . .
	£'000	—	—	—	—	363	—	4	—	—	—	. . .	. . .
Sudan	tonnes	224	143	277	720	2,405	129	245	190	76	—	. . .	. . .
	£'000	20	10	20	65	180	14	28	21	9	—	. . .	. . .
Syria	tonnes	10	25	39	15	67	264	895	2,087	2,445	840	1,346	1,368
	£'000	1	3	4	2	8	31	125	307	393	139	229	280
Arab Republic of Egypt	tonnes	—	214	335	291	723	2,872	4,149	3,105	1,169	1,935	5,168	2,586
	£'000	—	23	32	31	89	314	541	446	189	282	737	469
Brazil	tonnes	32	183	—	328	1,489	1,251	922	1,758	4,470	2,033	. . .	2,350
	£'000	3	14	—	35	161	122	103	202	514	244	. . .	432
Mexico	tonnes	—	—	—	—	236	56	74	118	146	55	. . .	. . .
	£'000	—	—	—	—	32	8	11	18	26	9	. . .	. . .
Other Countries	tonnes	505	48	119	10	748	278	7	243	113	403[b]	7,997	1,557
	£'000	30	4	9	1	52	31	—	31	14	61	835	381

Source: *Comercio con L'Estero* *Instituto Centrale di Statistica*

Footnotes: — nil or negligible . . . information not available a Statistica Mensile del Comercio Con L'Estero b includes 348 tonnes valued at £54,000 from USA.

Table 14

Imports of groundnut kernels into the Netherlands

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	49,803	35,797	39,024	39,152	34,851	35,694	58,916	42,247	39,063	37,666	45,406	45,012
	£'000	3,493	2,635	3,119	3,959	3,644	3,354	5,182	4,739	4,939	5,365	6,141	9,456
of which from:													
Belgium/Luxembourg	tonnes	1	2,350	22	43	2	62	253	86	70	202	2	–
	£'000	–	149	1	3	–	5	19	9	11	25	1	–
Federal Republic of Germany	tonnes	255	206	2,893	427	194	489	689	1,088	1,879	1,059	672	810
	£'000	25	22	211	45	20	45	64	117	131	137	99	141
UK	tonnes	631	488	635	854	1,170	802	675	580	694	218	547	532
	£'000	51	46	51	69	108	63	56	63	98	18	64	89
Poland	tonnes	–	–	–	–	–	–	36	–	294	247	–	
	£'000	–	–	–	–	–	–	3	–	43	37	–	–
China	tonnes	40	–	6,117	11,214	15,058	16,557	10,261	2,511	394	156	1,900	4,962
	£'000	4	–	548	1,206	1,687	1,628	1,121	363	59	21	286	1,183
India	tonnes	6,784	8,703	5,184	27	–	–	1,799	6,654	5,922	5,191	2,012	21
	£'000	577	719	450	2	–	–	168	817	700	693	270	2
Indonesia	tonnes	–	–	103	1,192	1,054	524	70	1,365	194	121	–	–
	£'000	–	–	8	118	92	48	8	159	25	16	–	–
Angola	tonnes	198	100	19	25	–	–	–	47	97	–	–	–
	£'000	16	9	2	3	–	–	–	6	12	–	–	
Gambia	tonnes	–	–	–	1,669	244	28	–	78	146	221	–	244
	£'000	–	–	–	113	15	2	–	8	18	27	–	51
Kenya/Uganda	tonnes	32	–	92	78	18	–	–	–	329[a]	621	41	
	£'000	3	–	8	7	1	–	–	–	39	83	5	
Mozambique	tonnes	416	1,630	312	13	32	267	2,816	1,343	634	1,525	1,367	1,753
	£'000	29	103	25	1	3	20	225	116	63	180	162	294

Table 14—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Nigeria	tonnes	15,552	5,864	2,813	3,604	4,484	1,157	20,967	10,593	6,691	2,392	307	5,129
	£'000	947	343	190	326	409	100	1,389	1,093	780	307	40	1,066
Rhodesia	tonnes	3,395	3,709	3,848	12	36	—	—	—	—	—	—	—
	£'000	258	274	301	1	3	—	—	—	—	—	—	—
Malawi	tonnes	...	...	...	986	403	688	3,375	2,812	1,816	933	998	1,561
	£'000	...	...	...	79	38	49	288	246	195	107	116	303
Zambia	tonnes	...	...	...	101	51	751	44	58	174	86	—	128
	£'000	...	...	...	10	5	64	4	7	22	12	—	28
Senegal, Gabon, Dahomey etc.	tonnes	101	30	20	50	—	73	—	23	5,482	926	2,678	1,085
	£'000	7	3	2	4	—	6	—	3	713	114	351	222
Republic of South Africa	tonnes	18,225	5,446	6,286	6,223	4,072	5,527	9,298	7,415	9,961	11,889	10,368	10,951
	£'000	1,291	485	565	736	498	611	989	1,008	1,524	1,919	1,647	2,076
Sudan	tonnes	3,348	6,227	5,725	3,943	4,813	774	3,301	4,747	1,055	222	609	157
	£'000	219	400	383	357	452	69	220	381	109	25	80	33
Tanzania	tonnes	135	471	709	20	—	61	—	—	74	—	—	—
	£'000	10	36	54	1	—	4	—	—	8	—	—	—
Arab Republic of Egypt	tonnes	—	24	—	189	53	—	—	1,445	40	165	45	—
	£'000	—	3	—	17	7	—	—	182	6	23	7	—
Brazil	tonnes	274	254	—	—	32	—	—	224	736	1,137	195	212
	£'000	22	18	—	—	2	—	—	27	93	141	24	50
Canada	tonnes	—	29	—	—	—	—	—	72	1,331	52	—	117
	£'000	—	2	—	—	—	—	—	10	158	5	—	30
USA	tonnes	274	102	3,894	8,166	2,995	7,911	5,290	819	809	9,864	23,354	16,981
	£'000	20	8	293	824	286	637	624	88	109	1,416	2,958	3,754
Other Countries	tonnes	142	164	352	316	140	23	42	287	570	439	311	629[b]
	£'000	14	15	27	37	18	3	4	36	62	59	31	134

Source: *Maandstatistiek van de Invoor* *Central Bureau voor de Statistiek*

Footnotes: — nil or negligible ... information not available a Kenya b of which 345 tonnes valued at £72,000 from Argentina

Table 15

Imports of groundnuts in-shell into the Netherlands

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	6,424	5,138	4,850	4,383	5,700	6,619	5,149	3,625	4,859	3,621	4,275	3,915
	£'000	636	559	526	511	711	750	647	518	672	542	636	885
of which from:													
Belgium/Luxembourg	tonnes	89	–	21	–	–	50	57	–	67	1	13	–
	£'000	7	–	1	–	–	3	6	–	6	–	2	–
France	tonnes	35	–	–	126	57	–	–	–	76	59	13	87
	£'000	4	–	–	14	7	–	–	–	9	8	2	18
Federal Republic of Germany	tonnes	32	66	60	29	–	53	98	37	369	79	126	69
	£'000	3	6	5	2	–	4	9	5	6	8	17	14
Portugal	tonnes	–	31	–	–	15	–	–	–	–	–	–	–
	£'000	–	4	–	–	2	–	–	–	–	–	–	–
Spain	tonnes	250	367	196	166	139	86	62	59	50	56	43	30
	£'000	39	56	33	30	23	16	14	15	12	12	12	11
China	tonnes	–	–	1,373	1,620	3,129	4,236	3,341	2,421	1,232	1,016	1,446	818
	£'000	–	–	162	201	421	499	463	371	214	186	225	212
India	tonnes	18	–	45	–	–	–	25	–	202	294	475	321
	£'000	2	–	4	–	–	–	2	–	26	36	66	61
Indonesia	tonnes	654	194	51	78	309	–	20	–	51	–	–	–
	£'000	53	15	3	6	25	–	2	–	9	–	–	–
Israel	tonnes	–	–	–	–	11	243	10	117	273	245	315	416
	£'000	–	–	–	–	1	29	1	18	47	43	58	98
Lebanon	tonnes	97	69	23	58	–	–	22	–	49	49	–	[illegible]
	£'000	10	8	3	4	–	–	3	–	8	8	–	[illegible]
Congo Peoples Republic	tonnes	272	104	–	35	59	50	24	25	61	–	–	–
	£'000	30	11	–	4	7	6	3	3	6	–	–	–

Table 15—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Ethiopia	tonnes	592	347	240	106	58	–	89	–	–	37	19	11
	£'000	52	33	21	11	7	–	9	–	–	4	3	2
Libya	tonnes	2,161	2,297	1,827	516	128	178	20	32	43	15	–	–
	£'000	213	259	201	62	18	19	3	2	3	3	–	–
Senegal	tonnes	–	–	–	–	–	–	–	–	752	16	153	–
	£'000	–	–	–	–	–	–	–	–	121	2	26	–
Madagascar	tonnes	360	259	–	398	370	264	228	246	178	286	154	858
	£'000	39	27	–	46	47	31	29	34	24	40	24	179
Gabon	tonnes	–	–	20	302	67	96	106	58	212	12	244	78
	£'000	–	–	2	30	8	11	11	7	24	2	27	16
Republic of South Africa	tonnes	229	73	65	61	–	22	27	44	54	–	–	–
	£'000	19	6	6	6	–	2	3	7	7	–	–	–
Sudan	tonnes	99	286	250	362	356	987	708	329	133	161	137	155
	£'000	9	21	23	35	33	88	56	30	11	16	15	30
Arab Republic of Egypt	tonnes	311	641	246	281	127	148	16	37	529	535	397	223
	£'000	37	73	26	32	15	16	2	5	86	84	60	58
Brazil	tonnes	27	–	48	–	190	–	50	125	343	419	565	150
	£'000	2	–	4	–	10	–	5	14	40	52	76	26
Mexico	tonnes	394	122	84	134	557	132	12	–	24	58	9	–
	£'000	43	13	8	16	70	17	2	–	3	10	2	–
USA	tonnes	20	21	47	24	29	–	–	–	–	37	26	292
	£'000	2	2	4	3	4	–	–	–	–	6	3	73
Other countries	tonnes	784	261	254	87	99	74	234	95	161	246	140	384
	£'000	72	25	20	4	13	9	24	7	8	22	18	82

Source: *Maanstatiskiek van de Invoor* *Central Bureau voor de Statistiek*

Footnote: – nil or negligible

Table 16

Imports of groundnut kernels into Norway

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	6,741	6,030	4,951	6,239	8,476	7,075	11,401	3,453	4,950	2,298	3,253	
	£'000	442	399	397	557	664	560	883	407	572	372	496	
of which from:													
Netherlands	tonnes	–	30	22	51	25	26	13	9	–	15	8	
	£'000	–	4	3	7	3	1	2	2	–	3	1	
UK	tonnes	63	9	35	10	30	92	100	65	38	47	–	
	£'000	8	1	3	1	4	10	12	12	9	10	–	
China	tonnes	28	–	383	1,271	1,085	1,199	162	363	15	–	126	
	£'000	4	–	47	164	135	146	22	59	3	–	23	
India	tonnes	304	495	311	–	–	23	88	348	692	–	–	
	£'000	30	44	28	–	–	3	11	47	97	–	–	
Israel	tonnes	361	207	212	90	–	–	–	–	–	–	–	
	£'000	60	36	36	17	–	–	–	–	–	–	–	
Arab Republic of Egypt	tonnes	30	139	200	–	–	–	–	363	–	–	–	
	£'000	4	20	27	–	–	–	–	64	–	–	–	
Malawi/Rhodesia/Zambia	tonnes	22	29	–	–	–	–	–	35[a]	–	13[a]	578	
	£'000	3	3	–	–	–	–	–	6	–	2	86	
Nigeria	tonnes	5,117	5,040	2,020	2,604	2,563	5,136	8,605	1,715	3,443	308	59	
	£'000	310	283	130	198	179	348	555	131	327	38	8	
Republic of South Africa	tonnes	181	81	75	107	32	57	1,021	157	110	100	175	
	£'000	20	8	8	15	4	6	69	22	17	16	27	
Sudan	tonnes	–	–	1,542	1,933	4,566	–	–	9	–	–	–	
	£'000	–	–	98	134	317	–	–	2	–	–	–	
Mexico	tonnes	–	–	–	–	46	–	–	86	–	–	–	
	£'000	–	–	–	–	6	–	–	14	–	–	–	
USA	tonnes	–	–	120	156	127	64	1,383	285	541	1,802	2,275	
	£'000	–	–	13	18	16	7	208	46	103	300	344	
Other Countries	tonnes	35	–	31	17	2	478[b]	29	18	111	13	32	
	£'000	3	–	4	3	–	39	4	2	16	3	7	

Source: *Foreign Trade of Norway* *Statistisk Sentralbyrå*

Footnotes: – nil or negligible a Malawi b Total includes 469 tonnes valued at £34,000 from Tanzania

Table 17

Imports of groundnuts in-shell into Norway

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	87	130	108	73	98	133	106	88	233	424	128	
	£'000	12	17	15	10	15	16	15	15	36	65	25	
of which from:													
UK	tonnes	–	–	–	–	–	29	–	14	18	11	8	
	£'000	–	–	–	–	–	3	–	4	4	3	4	
China	tonnes	–	–	48	–	94	103	74	63	56	–	85	
	£'000	–	–	6	–	14	13	11	10	10	–	15	
India	tonnes	–	–	–	–	–	–	25	–	–	315	–	
	£'000	–	–	–	–	–	–	3	–	–	46	–	
Israel	tonnes	–	15	15	10	–	–	–	–	24	–	–	
	£'000	–	2	2	2	–	–	–	–	4	–	–	
Arab Republic of Egypt	tonnes	–	63	–	–	–	–	–	–	–	34	–	
	£'000	–	8	–	–	–	–	–	–	–	5	–	
Libya	tonnes	64	35	–	–	–	–	–	–	–	–	–	
	£'000	9	4	–	–	–	–	–	–	–	–	–	
Nigeria	tonnes	–	–	–	–	–	–	–	–	129	–	–	
	£'000	–	–	–	–	–	–	–	–	16	–	–	
Republic of South Africa	tonnes	10	–	–	46	–	–	–	–	–	50	30	
	£'000	1	–	–	6	–	–	–	–	–	8	5	
Other countries	tonnes	13	17	45	17	4	1	7	11	6	14	5	
	£'000	2	3	7	2	1	–	1	1	2	3	1	

Source: *Foreign Trade of Norway* *Statistisk Sentralbyrå*

Footnote: – nil or negligible

Table 18

Imports of groundnut kernels into Portugal

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	15,459	54,819	38,488	88,566	98,685	134,003	114,131	97,020	45,931	38,903	64,828	47,303
	£'000	966	3,360	2,589	6,641	6,919	9,595	8,329	8,205	4,114	4,466	6,817	7,120
of which from:													
Angola	tonnes	792	1,630	683	527	324	929	277	353	613	97	–	107
	£'000	48	88	40	38	23	68	20	32	42	9	–	18
Gambia	tonnes	–	–	–	–	19,478	21,182	2,362	13,464	–	2,565	7,264	2,941
	£'000	–	–	–	–	1,424	1,560	169	1,207	–	298	801	476
Guinea	tonnes	14,646	12,778	14,131	13,193	11,567	11,048	11,496	13,062	13,369	5,926	9,647	9,575
	£'000	917	865	931	932	833	763	988	1,143	1,182	481	842	1,036
Niger	tonnes	–	–	–	–	3,579	6,119	7,362	–	–	3,000	12,941	5,011
	£'000	–	–	–	–	262	467	588	–	–	349	1,429	1,013
Nigeria	tonnes	–	32,456	23,160	69,612	28,462	71,897	78,994	69,150	23,127	23,430	1,926	50
	£'000	–	1,929	1,582	5,288	2,117	5,068	5,641	5,730	2,101	2,878	215	15
Mozambique	tonnes	–	–	–	–	5	–	–	416	–	50	139	196
	£'000	–	–	–	–	–	–	–	37	–	6	19	31
Senegal	tonnes	–	–	–	5,091	31,482	14,048	6,308	–	–	–	–	–
	£'000	–	–	–	374	1,973	1,061	492	–	–		–	–
Republic of South Africa	tonnes	–	3,805	6	–	–	5,602	6,106	–	3,979	–	–	
	£'000	–	231	–	–	–	367	355	–	360	–	–	
Sudan	tonnes	–	4,145	500	–	–	2,617	–	–	–	985	–	
	£'000	–	247	36	–	–	197	–	–	–	114	–	
Brazil	tonnes	20	5	–	20	12	55	10	258	1,712	34	9,615	10,560
	£'000	1	–	–	2	1	5	1	27	149	5	988	1,543
Canada	tonnes	–	–	–	–	–	–	–	–	–	–	2,000	
	£'000	–	–	–	–	–	–	–	–	–		205	

Table 18—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Panama	tonnes	–	–	–	–	–	–	–	–	–	–	1,041	–
	£'000	–	–	–	–	–	–	–	–	–	–	116	–
USA	tonnes	–	–	–	–	3,677	–	–	–	–	2,815	19,761	18,269
	£'000	–	–	–	–	279	–	–	–	–	326	2,160	2,923
Other Countries	tonnes	1	–	8	123	99	406[a]	1,216[b]	317	3,131[c]	1	494	592
	£'000	–	–	–	7	7	39	75	29	280	–	42	65

Source: *Comercio Externo* *Instituto Nacional de Estadistica*

Footnotes: – nil or negligible a Includes 496 tonnes valued at £38,000 from Ivory Coast b Includes 1,009 tonnes valued at £56,000 from Malawi c Includes 2,526 tonnes valued at £228,000 from Arab Republic of Egypt

Table 19

Imports of groundnuts in-shell into Portugal

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	26,710	25,135	21,019	4,876	5,913	8,439	2,063	28,616	2,975	5,582	9,945	6 583
	£'000	1,170	1,193	1,053	362	488	635	196	2,367	309	581	1,073	869
of which from:													
USA	tonnes	–	–	–	–	–	–	–	–	–	998	2,261	616
	£'000	–	–	–	–	–	–	–	–	–	116	236	88
Turkey	tonnes	–	99	–	151	98	69	–	21	–	–	–	–
	£'000	–	11	–	20	13	9	–	3	–	–	–	–
Israel	tonnes	377	292	415	484	718	335	421	424	393	715	479	268
	£'000	42	31	48	60	85	39	54	57	53	106	71	45
Lebanon	tonnes	49	27	–	173	–	49	–	–	–	–	–	–
	£'000	4	3	–	21	–	6	–	–	–	–	–	–
Angola	tonnes	168	120	315	585	605	306	154	252	–	472	–	329
	£'000	9	5	18	39	41	16	8	16	–	35	–	37
Arab Republic of Egypt	tonnes	–	54	–	–	–	–	–	6,101	–	–	–	–
	£'000	–	5	–	–	–	–	–	524	–	–	–	–
Cape Verde Islands	tonnes	130	155	306	296	513	477	485	10	–	–	–	–
	£'000	9	11	19	23	38	32	34	1	–	–	–	–
Guinea	tonnes	25,717	24,090	19,784	1,903	37	500	–	650	587	453	662	2,691
	£'000	1,089	1,105	954	99	2	36	–	57	40	40	32	273
Mozambique	tonnes	–	–	–	196	–	75	15	151	72	1,071	675	198
	£'000	–	–	–	8	–	4	1	15	7	60	40	24
Niger	tonnes	–	–	–	–	–	–	–	2,085	–	–	–	–
	£'000	–	–	–	–	–	–	–	176	–	–	–	–
Nigeria	tonnes	–	–	–	–	3,406	5,660	–	15,788	–	20	–	10
	£'000	–	–	–	–	259	410	–	1,189	–	3	–	[illegible]
Brazil	tonnes	269	274	79	1,023	506	918	939	2,796	1,923	1,852	3,420	[illegible]
	£'000	17	18	4	86	47	76	92	300	209	221	419	[illegible]
Other Countries	tonnes	–	24	120	65	30	50	49	338	–	–	2,448[a]	–
	£'000	–	4	10	6	3	7	7	29	–	–	275	–

Source: *Comercio Externo* *Instituto Nacional de Estadistica*

Footnotes: – nil or negligible a Includes 2,447 tonnes valued at £274,000 from Gambia

Table 20

Imports of groundnuts into Spain

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	23,951	14,447	22,189	28,611	21,163	21,431	35,448	43,088	26,725	27,528	27,533	24,692
	£'000	1,294	1,003	1,630	2,371	1,869	1,630	2,590	4,150	2,676	3,321	3,296	4,698
of which from:													
Turkey	tonnes	–	–	–	–	102	–	–	–	–	–	–	–
	£'000	–	–	–	–	11	–	–	–	–	–	–	–
Cameroon	tonnes	–	–	505	397	573	20	–	–	–	–	–	–
	£'000	–	–	31	28	45	1	–	–	–	–	–	–
Angola	tonnes	–	330	1,565	171	1,042	–	–	–	–	200	–	–
	£'000	–	26	116	16	102	–	–	–	–	24	–	–
Ethiopia	tonnes	–	5	1,583	649	211	90	678	810	–	381	–	702
	£'000	–	1	132	65	17	6	56	81	–	46	–	118
Kenya	tonnes	–	–	149	192	301	–	–	–	–	28	–	19
	£'000	–	–	12	19	30	–	–	–	–	3	–	3
Uganda	tonnes	–	10	51	166	148	25	–	–	–	–	–	–
	£'000	–	1	4	12	11	3	–	–	–	–	–	–
Tanzania	tonnes	–	230	525	137	524	129	–	–	–	–	–	–
	£'000	–	17	42	14	48	10	–	–	–	–	–	–
Libya	tonnes	–	–	20	–	–	–	6,121	–	–	146	2,234	832
	£'000	–	–	2	–	–	–	446	–	–	20	259	117
Rhodesia	tonnes	...	...	530	–	–	–	–	–	–	–	–	–
	£'000	...	...	51	–	–	–	–	–	–	–	–	–
Zambia	tonnes	5	405	251	–	133	192	79	–	5	–	1,039	75
	£'000	–	38	24	–	12	20	11	–	1	–	124	15
Malawi	tonnes	...	...	896	349	513	1,283	3,092	582	112	1,461	265	84
	£'000	...	...	87	40	58	99	251	66	15	195	42	13

Table 20—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Morocco	tonnes	458	—	—	—	—	—	—	—	—	—	—	—
	£'000	31	—	—	—	—	—	—	—	—	—	—	—
Madagascar	tonnes	—	—	584	55	—	—	1,049	—	—	657	637	358
	£'000	—	—	58	6	—	—	98	—	—	74	86	63
Nigeria	tonnes	20,252	5,903	11,031	15,695	2,362	8,111	7,415	10,125	11,124	3,258	1,509	21
	£'000	1,009	355	705	1,152	164	535	482	858	1,019	359	158	6
Senegal	tonnes	—	—	—	—	1,049	1,085	9,639	7,436	5	—	—	55
	£'000	—	—	—	—	71	76	664	630	1	—	—	17
Republic of South Africa	tonnes	—	54	276	100	25	171	399	—	—	223	—	—
	£'000	—	6	27	10	2	18	33	—	—	28	—	—
Sudan	tonnes	1,038	2,596	2,867	2,863	7,414	5,460	6,026	8,159	702	1,798	243	147
	£'000	56	160	209	233	655	418	444	701	65	211	28	25
Upper Volta	tonnes	—	—	—	—	—	544	—	—	—	—	—	—
	£'000	—	—	—	—	—	34	—	—	—	—	—	—
Argentina	tonnes	—	—	—	40	538	—	110	—	—	781	911	—
	£'000	—	—	—	4	43	—	11	—	—	86	110	—
Brazil	tonnes	2,113	4,829	482	6,952	3,873	4,130	785	15,374	14,614	16,755	15,180	18,274
	£'000	188	394	45	692	390	389	86	1,756	1,549	2,037	1,781	3,344
Mexico	tonnes	—	—	252	—	684	—	—	—	—	436	122	
	£'000	—	—	26	—	70	—	—	—	—	55	16	
USA	tonnes	—	50	223	130	671	30	10	277	62	742	2,525	2,765
	£'000	—	4	24	14	70	4	1	—	8	99	357	706
Other Countries	tonnes	85	35	399	715	1,000	161	45	325	101	662	2,868[a]	1,340
	£'000	10	1	35	66	70	17	7	58	18	84	325	271

Source: *Comercio Exterior de España* *Ministerio de Hacienda*

Footnotes: — nil or negligible . . . information not available a includes 2,027 tonnes valued at £212,000 from Niger

Table 21

Imports of groundnut kernels into Sweden

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	440	381	481	575	905	958	929	1,021	866	655	1,340	
	£'000	50	47	57	77	110	107	109	169	140	115	226	
of which from:													
Federal Republic of Germany	tonnes	10	40	22	19	25	12	10	17	23	76	117	
	£'000	2	10	6	3	3	1	2	3	5	14	22	
Netherlands	tonnes	84	109	138	114	146	97	92	108	221	101	56	
	£'000	12	14	18	17	21	15	13	19	37	19	11	
UK	tonnes	10	–	–	–	–	–	–	15	156	30	44	
	£'000	1	–	–	–	–	–	–	2	21	4	9	
China	tonnes	–	–	41	179	22	40	17	–	–	–	–	
	£'000	–	–	5	26	2	5	2	–	–	–	–	
India	tonnes	136	53	29	11	–	–	9	412	211	92	–	
	£'000	14	6	3	1	–	–	1	58	34	15	–	
Malawi	tonnes	–	–	52	50	94	150	142	112	83	60	90	
	£'000	–	–	5	6	12	18	16	20	16	12	18	
Rhodesia/Zambia/Malawi	tonnes	172	156	–	39	...	...	...	...	...	...	...	
	£'000	17	15	–	4	...	...	...	...	...	...	...	
Zambia	tonnes	–	–	83	29	30	10	10	–	–	–	–	
	£'000	–	–	7	4	5	1	1	–	–	–	–	
Nigeria	tonnes	–	–	25	–	168	14	–	–	–	–	–	
	£'000	–	–	3	–	19	1	–	–	–	–	–	
Republic of South Africa	tonnes	22	–	74	31	–	–	–	6	62	18	17	
	£'000	3	–	9	4	–	–	–	2	9	3	3	
Tanzania	tonnes	–	–	–	–	–	26	–	–	24	41	15	
	£'000	–	–	–	–	–	2	–	–	2	4	1	
USA	tonnes	–	–	–	25	341	587	638	129	44	213	523	
	£'000	–	–	–	3	39	60	72	27	10	40	86	
Other Countries	tonnes	6	23	17	78	79	22	11	222	42	24	472[a]	
	£'000	1	2	1	9	9	4	2	38	6	4	75	

Source: *Sveriges Införsel och Utförsel* *Statistiska Centralbyrån*

Footnotes: . . . information not available – nil or negligible a of which 447 tonnes valued at £73,000 from the Sudan

Table 22

Imports of groundnuts in-shell into Sweden

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	170	198	135	119	115	72	117	75	204	288	113	
	£'000	24	26	18	16	17	10	19	13	34	44	20	
of which from:													
Turkey	tonnes	–	16	15	–	–	–	–	–	–	–	–	
	£'000	–	2	2	–	–	–	–	–	–	–	–	
China	tonnes	–	–	–	15	23	34	94	46	60	17	63	
	£'000	–	–	–	2	3	5	15	8	11	4	12	
India	tonnes	–	49	–	–	–	–	–	–	55	226	–	
	£'000	–	5	–	–	–	–	–	–	9	33	–	
Israel	tonnes	119	73	11	–	45	–	–	–	–	–	–	
	£'000	17	12	2	–	7	–	–	–	–	–	–	
Syria	tonnes	–	–	–	–	14	12	5	–	–	–	–	
	£'000	–	–	–	–	2	2	1	–	–	–	–	
Arab Republic of Egypt	tonnes	–	8	28	31	10	16	–	11	29	30	5	
	£'000	–	1	4	4	1	2	–	2	5	5	1	
Libya	tonnes	7	7	31	–	–	5	–	7	10	–	–	
	£'000	1	1	4	–	–	1	–	1	2	–	–	
Sudan	tonnes	23	20	19	27	–	–	6	–	9	14	32	
	£'000	3	2	2	4	–	–	1	–	1	2	5	
Mexico	tonnes	7	17	16	30	12	–	–	–	–	–	–	
	£'000	1	2	2	4	2	–	–	–	–	–	–	
Other Countries	tonnes	14	8	15	16	11	5	12	11	41	1	10	
	£'000	2	1	2	2	2	–	2	2	6	–	2	

Source: *Sveriges Införsel och Utförsel* *Statistiska Centralbyrån*

Footnote: – nil or negligible

Table 23

Imports of non-roasted groundnuts into Switzerland

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	74,240	66,104	75,729	70,642	77,209	61,999	77,188	46,840	80,889	57,163	55,898	65,718
	£'000	5,008	4,295	5,239	5,616	5,798	4,474	5,799	4,128	7,577	6,490	6,152	10,891
of which from:													
France	tonnes	22	39	48	73	53	70	71	68	50	41	41	26
	£'000	4	6	7	11	9	12	13	14	11	9	9	8
Netherlands	tonnes	43	69	62	49	55	33	36	42	44	40	42	26
	£'000	6	9	8	7	7	4	6	7	8	7	7	7
Turkey	tonnes	140	218	75	–	38	–	–	43	288	318	88	272
	£'000	17	28	9	–	6	–	–	7	54	59	17	65
China	tonnes	–	–	7	277	293	882	960	705	146	23	437	281
	£'000	–	–	1	41	44	119	149	123	27	5	75	80
Israel	tonnes	1,060	730	420	677	916	796	–	1,138	1,808	1,854	2,019	1,941
	£'000	150	108	60	99	135	112	–	203	335	335	378	529
Lebanon	tonnes	133	253	527	1,093	269	41	–	279	–	–	–	25
	£'000	17	21	60	134	35	5	–	50	–	–	–	6
Syria	tonnes	211	117	257	230	131	96	1,376	249	69	–	–	100
	£'000	24	13	30	33	17	12	224	39	13	–	–	31
Cameroon	tonnes	–	–	–	–	875	–	–	1,271	487	–	–	2,203
	£'000	–	–	–	–	65	–	–	111	41	–	–	342
Dahomey	tonnes	–	–	–	–	370	–	–	–	1,440	517	767	746
	£'000	–	–	–	–	27	–	–	–	123	56	81	127
Gambia	tonnes	2,312	2,429	–	3,802	2,290	3,152	–	6,100	12,635	14,381	11,603	10,193
	£'000	160	152	–	297	172	221	–	516	1,078	1,578	1,201	1,545
Kenya, etc.	tonnes	1,169	32	–	26	–	642	–	–	–	–	–	–
	£'000	75	2	–	1	–	44	–	–	–	–	–	–
Libya	tonnes	73	–	18	–	–	–	10	–	–	–	–	–
	£'000	9	–	2	–	–	–	1	–	–	–	–	–
Mali	tonnes	–	–	–	–	–	–	–	–	–	1,634	499	–
	£'000	–	–	–	–	–	–	–	–	–	196	51	–

Table 23—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Niger	tonnes	–	–	2,022	3,037	–	–	501	529	1,693	2,983	6,190	2,555
	£'000	–	–	131	227	–	–	34	48	152	336	656	407
Nigeria	tonnes	64,148	45,335	48,595	47,648	62,249	40,479	52,348	34,786	52,840	19,896	17,797	29,847
	£'000	4,089	2,760	3,238	3,682	4,473	2,807	3,731	2,755	4,754	2,110	1,895	4,920
Rhodesia	tonnes	. . .	. . .	7	–	–	–	–	–	–	–	–	–
	£'000	. . .	. . .	1	–	–	–	–	–	–	–	–	–
Malawi	tonnes	208	524	7	21	20	–	60	45	26	17	30	43
	£'000	25	50	1	3	3	–	8	7	4	3	5	11
Zambia	tonnes	. . .	. . .	375	–	–	1,402	28	139	595	1,159	–	–
	£'000	. . .	. . .	45	–	–	101	4	32	115	127	–	–
Senegal	tonnes	–	–	–	–	3,246	–	6,913	42	133	1,056	–	94
	£'000	–	–	–	–	219	–	508	8	25	120	–	26
Republic of South Africa	tonnes	1,522	1,253	15,989	124	–	3,476	12,100	209	5,483	506	–	–
	£'000	104	80	1,030	8	–	229	788	38	508	52	–	–
Sudan	tonnes	1,224	12,651	4,525	10,179	1,910	9,602	1,057	45	–	10,457	10,934	6,511
	£'000	85	759	301	711	130	628	78	7	–	1,150	1,104	901
Arab Republic of Egypt	tonnes	258	429	34	217	155	191	270	306	336	62	144	53
	£'000	29	51	3	26	20	22	39	48	56	10	23	13
Upper Volta	tonnes	–	–	–	–	–	–	–	–	1,455	–	1,893	3,330
	£'000	–	–	–	–	–	–	–	–	122	–	199	573
Brazil	tonnes	–	–	–	–	433	–	–	–	–	–	–	
	£'000	–	–	–	–	30	–	–	–	–		–	
Mexico	tonnes	1,665	1,990	2,106	1,733	1,826	1,113	1,115	544	359	970	485	117
	£'000	208	252	265	229	245	138	163	91	69	182	94	39
USA	tonnes	–	15	648	1,278	1,865	–	24	–	–	355	2,915	7,339
	£'000	–	2	46	93	145	–	3	–	–	63	354	1,267
Other Countries	tonnes	63	20	7	178	215	24	319	299	1,002[a]	894[a]	14	16
	£'000	6	2	1	14	16	20	50	24	82	92	3	4

Source: *Statistique de la Suisse* *Bureau Fédéral de Statistique*

Footnotes: . . . information not available — nil or negligible

a 1970 figures include 992 tonnes valued at £82,400 } Exported from TOGO
1971 figures include 888 tonnes valued at £91,600 }

Table 24

Imports of groundnut kernels into the UK

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	211,034	193,609	146,843	89,286	75,466	99,838	116,250	69,670	59,703	48,751	59,534	70,738
	£'000	13,752	12,443	10,265	7,436	6,778	8,111	8,584	6,862	7,291	6,099	7,698	10,762
of which from:													
Federal Republic of Germany	tonnes	140	19	198	93	18	494	–	44	33	65	26	26
	£'000	11	2	15	11	3	41	–	8	6	11	5	...
Italy	tonnes	–	91	23	110	732	–	–	–	–	–	–	–
	£'000	–	15	3	14	51	–	–	–	–	–	–	–
Netherlands	tonnes	122	119	1,319	708	1,197	1,817	226	476	326	513	1,077	778
	£'000	15	13	108	73	96	152	24	66	61	87	157	...
Switzerland	tonnes	–	–	–	–	–	–	–	–	225	59	195	174
	£'000	–	–	–	–	–	–	–	–	28	7	31	...
China	tonnes	–	–	583	4,804	7,715	6,745	2,259	3,904	–	–	4,442	62
	£'000	–	–	57	567	848	729	241	573	–	–	643	...
India	tonnes	14,377	11,390	9,894	–	–	56	3,966	8,779	6,087	4,386	6,156	605
	£'000	1,263	919	897	–	–	2	259	740	806	603	831	121
Ethiopia	tonnes	6	9	–	–	–	–	–	30	295	–	–	6
	£'000	1	1	–	–	–	–	–	3	40	–	–	...
Gambia	tonnes	19,082	2,514	4,531	–	–	–	2,315	–	1	51	283	16
	£'000	1,167	151	286	–	–	–	156	–	–	7	31	...
Kenya	tonnes	773	1,415	242	21	2,043	345	1,476	631	315	569	1	16
	£'000	46	101	19	2	148	23	158	67	43	76	–	...
Rhodesia/Malawi/Zambia	tonnes	10,040	14,544	14,287	...	...	...	...	...	...	...	...	...
	£'000	912	1,217	1,197	...	...	...	...	...	...	...	...	...
Malawi	tonnes	...	...	...	14,588	13,234	25,206	17,767	24,709	24,996	22,201	20,640	32,513
	£'000	...	...	...	1,176	1,440	2,137	1,570	2,433	2,755	2,615	2,516	4,115
Rhodesia	tonnes	...	...	...	113	–	–	–	–	–	–	–	–
	£'000	...	...	...	13	–	–	–	–	–	–	–	–
Zambia	tonnes	...	...	...	1,656	3,470	4,573	5,878	3,020	2,912	1,426	3,283	1,978
	£'000	...	...	...	189	320	449	636	341	448	203	466	361

Table 24—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Senegal	tonnes	–	–	–	–	–	–	–	10	679	–	51	–
	£'000	–	–	–	–	–	–	–	1	82	–	5	–
Nigeria	tonnes	148,187	143,225	91,820	46,536	33,177	36,493	57,793	19,015	12,913	11,130	12,099	21,576
	£'000	8,945	8,553	5,836	3,281	2,348	2,397	3,790	1,636	1,483	1,332	1,469	. . .
Republic of South Africa	tonnes	13,274	17,918	18,867	5,816	3,745	13,797	17,350	7,409	7,044	5,805	5,289	9,369
	£'000	1,074	1,293	1,422	714	489	1,137	1,143	813	1,027	827	788	. . .
Sudan	tonnes	–	182	25	1,717	115	75	–	–	310	111	–	–
	£'000	–	19	2	175	11	6	–	–	38	15	–	–
Tanzania	tonnes	340	199	1,323	2,384	333	1,935	1,450	291	229	–	8	–
	£'000	26	17	106	241	36	147	137	29	24	–	3	–
Uganda	tonnes	4,137	1,175	1,791	114	2,258	201	–	115	105	25	–	–
	£'000	232	68	108	10	146	15	–	13	11	2		–
Brazil	tonnes	247	629	–	2,694	52	175	25	248	1,887	961	974	641
	£'000	20	47	–	222	9	16	3	30	223	116	119	. . .
Canada	tonnes	–	–	–	147	–	178	–	253	62	25	433	
	£'000	–	–	–	13	–	21	–	21	10	4	57	–
USA	tonnes	–	–	1,862	5,169	7,133	7,444	5,265	–	947	1,244	3,605	2,428
	£'000	–	–	196	546	806	813	434	–	153	172	452	
Windward Islands	tonnes	–	–	–	2,454	–	–	–	–	–	–	–	–
	£'000	–	–	–	171	–	–	–	–	–		–	–
Other Countries	tonnes	309	180	78	162	244	304	380	736	337	180	972	399
	£'000	40	27	13	18	27	26	33	88	53	22	125	–

Source: *The Trade of the United Kingdom* *H.M. Customs and Excise*

Footnotes: . . . information not available — nil or negligible

Table 25

Imports of groundnuts in-shell into the UK

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973p
TOTALS	tonnes	4,757	4,207	3,327	3,533	5,551	4,650	3,471	3,479	2,663	2,114	5,341	4,670
	£'000	503	424	330	389	655	494	390	450	346	307	746	721
of which from:													
Netherlands	tonnes	20	106	60	26	433	777	290	256	90	10	59	947
	£'000	2	11	6	4	38	55	24	36	10	1	10	. . .
Switzerland	tonnes	–	–	–	–	–	10	112	195	92	301	245	301
	£'000	–	–	–	–	–	1	11	26	11	48	41	. . .
Turkey	tonnes	497	293	140	275	171	76	40	–	–	124	10	–
	£'000	53	33	15	32	22	9	6	–	–	19	2	–
China	tonnes	–	–	–	–	32	122	111	–	–	2	532	109
	£'000	–	–	–	–	5	15	14	–	–	1	70	. . .
India	tonnes	694	278	20	–	–	1	224	253	264	168	735	–
	£'000	61	24	2	–	–	–	23	30	31	19	95	–
Israel	tonnes	825	388	392	–	68	50	149	90	53	–	547	163
	£'000	101	51	46	–	9	6	19	14	9	–	83	29
Lebanon	tonnes	103	88	149	–	–	200	–	–	–	–	83	–
	£'000	12	10	15	–	–	23	–	–	–	–	12	–
Syria	tonnes	120	421	413	180	51	–	50	528	–	–	49	100
	£'000	14	48	44	16	6	–	7	74	–	–	7	. . .
Ethiopia	tonnes	1,503	1,554	729	1,777	1,489	1,232	443	791	820	173	598	752
	£'000	143	135	65	201	201	145	46	92	111	25	82	. . .
Libya	tonnes	711	814	1,077	138	572	–	–	13	–	–	–	–
	£'000	86	81	98	17	77	–	–	2	–	–	–	–
Madagascar	tonnes	–	–	–	–	–	518	510	151	–	203	38	386
	£'000	–	–	–	–	–	65	66	21	–	31	7	. . .

Table 25—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973p
Malawi	tonnes	–	–	–	–	432	–	–	201	–	–	199	–
	£'000	–	–	–	–	52	–	–	20	–	–	30	–
Nigeria	tonnes	–	–	–	–	–	46	–	72	1	33	323	31
	£'000	–	–	–	–	–	4	–	7	.	4	36	.
Senegal	tonnes	–	–	–	–	–	–	–	65	407	51	244	–
	£'000	–	–	–	–	–	–	–	6	34	6	34	–
Republic of South Africa	tonnes	–	–	31	–	–	60	–	–	10	–	85	36
	£'000	–	–	3	–	–	8	–	–	2	–	13	
Sudan	tonnes	9	48	172	106	450	319	365	136	42	97	–	–
	£'000	1	5	13	8	40	28	31	14	4	12	–	–
Arab Republic of Egypt	tonnes	111	41	25	379	899	666	975	524	547	187	702	330
	£'000	13	4	3	40	99	73	119	80	92	27	102	58
Brazil	tonnes	19	13	–	234	220	186	–	51	304	206	677	209
	£'000	2	1	–	24	24	21	–	6	37	27	95	
Mexico	tonnes	118	136	–	268	493	246	–	–	–	–	–	–
	£'000	14	17	–	32	62	30	–	–	–	.	–	–
USA	tonnes	–	–	–	–	–	–	–	–	13	488	49	1,081
	£'000	–	–	–	–	–	–	–	–	2	73	7	
Other countries	tonnes	27	27	119	150	241	141	202	153	20	71	166	225
	£'000	1	4	20	15	20	11	24	22	3	14	20	

Source: *The Trade of the United Kingdom* *H.M. Customs and Excise*

Footnotes: p Provisional. – nil or negligible . . . information not available

Table 26

Imports of groundnuts in and out of shell into Canada

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971[a]	1972[a]	1973[a]
TOTALS	tonnes	43,366	37,781	41,817	49,064	45,228	52,965	51,387	49,309	49,047	49,034	49,250	54,931
	£'000	3,611	2,899	3,353	4,660	4,155	4,406	4,820	6,772	7,744	5,917	5,335	10,838
of which from:													
Belgium/Luxembourg	tonnes	–	–	–	–	–	–	–	211	–	–	–	–
	£'000	–	–	–	–	–	–	–	23	–	–	–	–
Netherlands	tonnes	342	–	–	–	–	–	–	2,512	107	–	–	–
	£'000	38	–	–	–	–	–	–	322	16	–	–	–
UK	tonnes	34	–	15	–	–	–	–	77	61	–	–	16
	£'000	4	–	3	–	–	–	–	14	12	–	–	3
China	tonnes	834	–	5,233	8,240	7,331	16,969	14,328	15,156	1,543	417	4,349	775
	£'000	95	–	433	743	760	1,508	1,379	1,790	222	50	520	112
Hong Kong	tonnes	–	–	32	–	–	–	88	682	300	11	1	1
	£'000	–	–	2	–	–	–	9	89	49	2	–	–
India	tonnes	5,158	2,237	2,654	–	–	–	–	4,169	50	–	–	–
	£'000	421	172	226	–	–	–	–	583	9	–	–	–
Malawi	tonnes	–	–	166	–	–	548	1,463	–	–	–	–	–
	£'000	–	–	14	–	–	39	128	–	–	–	–	–
Rhodesia/Malawi/Zambia	tonnes	3,490	1,828	...	...	...	...	...	...	...	...	...	...
	£'000	273	128	...	...	...	...	...	...	...	...	...	...
Zambia	tonnes	–	–	115	32	–	–	–	116	9	–	–	806
	£'000	–	–	12	3	–	–	–	20	1	–	–	140
Nigeria	tonnes	25	–	–	–	162	73	456	850	577	–	–	–
	£'000	2	–	–	–	14	6	46	98	70	–	–	–
Republic of South Africa	tonnes	3,552	3,457	2,526	1,470	119	958	1,156	625	837	–	–	–
	£'000	297	300	224	163	13	84	108	92	129	–	–	–

Table 26—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971[a]	1972[a]	1973[a]
Tanzania	tonnes	–	528	198	–	–	–	–	–	–	–	–	–
	£'000	–	47	17	–	–	–	–	–	–	–	–	–
Kenya	tonnes	–	288	–	–	–	–	–	–	–	–	–	–
	£'000	–	26	–	–	–	–	–	–	–	–	–	–
Sudan	tonnes	48	198	–	–	–	–	–	–	–	–	–	–
	£'000	3	13	–	–	–	–	–	–	–	–	–	–
Arab Republic of Egypt	tonnes	330	200	–	–	–	–	–	1,002	–	–	–	399
	£'000	38	18	–	–	–	–	–	132	–	–	–	87
Argentina	tonnes	–	–	–	–	–	–	–	–	625	248	–	–
	£'000	–	–	–	–	–	–	–	–	81	32	–	–
Brazil	tonnes	11,568	6,507	–	1,942	–	–	–	1,131	245	–	–	61
	£'000	771	415	–	151	–	–	–	134	25	–	–	12
Mexico	tonnes	10,805	8,518	6,919	4,365	3,180	2,022	1,537	1,354	1,707	440	64	
	£'000	1,042	724	613	417	293	170	154	173	248	52	7	
USA	tonnes	7,165	14,019	23,958	33,015	34,436	32,394	32,359	21,424	42,985	47,918	44,735	52,871
	£'000	626	1,056	1,809	3,183	3,075	2,598	2,996	3,302	6,881	5,781	4,791	10 483
Other Countries	tonnes	15	1	1	–	–	1	–	–	1	–	102	2
	£'000	1	–	–	–	–	1	–	–	1	–	17	–

Source: *Trade of Canada* *Dominion Bureau of Statistics*

Footnotes: . . . information not available — nil or negligible a shelled

Table 27

Imports of groundnuts in-shell into Canada

		1971	1972	1973
TOTALS	tonnes	3,341	5,295	8,016
	£'000	404.1	564.6	651.0
of which from:				
Israel	tonnes	–	72	–
	£'000	–	8.1	–
Hong Kong	tonnes	1	–	164
	£'000	–	–	2.8
China	tonnes	661	2,957	656
	£'000	74.0	290.4	53.5
Arab Republic of Egypt	tonnes	–	–	106
	£'000	–	–	15.1
Brazil	tonnes	–	–	122
	£'000	–	–	17.1
Mexico	tonnes	1,508	1,935	996
	£'000	180.9	225.0	150.4
Nicaragua	tonnes	–	25	–
	£'000	–	2.0	–
USA	tonnes	1,172	306	5,971
	£'000	148.8	39.5	412.1

Footnote: Information not available before dates shown

Table 28

Imports of groundnut kernels into Hong Kong

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	11,244	11,252	10,666	7,817	10,340	8,422	12,091	9,870	10,935	8,380	8,590	8,970
	£'000	791	767	783	653	815	654	945	894	1,114	902	1,185	1,474
of which from:													
Khmer Republic (Cambodia)	tonnes	56	41	—	70	—	543	—	155	81	—	—	—
	£'000	5	3	—	5	—	45	—	15	5	—	—	—
China	tonnes	610	155	1,577	2,378	3,720	2,612	3,557	3,108	2,232	2,485	6,539	2,770
	£'000	56	15	141	223	363	245	335	361	315	341	972	447
Indonesia	tonnes	—	52	318	—	3,836	924	2,302	4,016	5,791	3,938	1,385	2,307
	£'000	—	5	23	—	244	50	138	261	514	371	135	373
Macão	tonnes	22	17	53	113	86	8	1	—	3	2	13	33
	£'000	2	1	4	9	7	1	—	—	—	—	2	6
Malaysia	tonnes	20	3	—	—	—	—	—	—	—	—	—	—
	£'000	1	—	—	—	—	—	—	—	—	—	—	—
Singapore	tonnes	. . .	. . .	20	20	15	541	1,925	1,188	444	337	196	591
	£'000	. . .	. . .	2	2	1	44	149	111	47	33	25	98
Vietnam Dem Rep.	tonnes	—	—	269	119	244	99	729	172	962	761	153	118
	£'000	—	—	18	10	14	8	53	17	91	71	14	15
Philippines	tonnes	187	—	—	—	70	—	—	—	—	—	—	—
	£'000	8	—	—	—	3	—	—	—	—	—	—	
Taiwan	tonnes	30	—	—	270	—	—	—	—	—	—	—	291
	£'000	4	—	—	18	—	—	—	—	—	—	—	47
Thailand	tonnes	1,209	1,246	187	2,027	1,856	244	595	1,231	1,421	806	273	2,401
	£'000	80	92	14	161	146	19	50	129	142	79	[illegible]	[illegible]
Vietnam Rep.	tonnes	366	127	947	1,857	245	—	—	—	—	—	6	—
	£'000	28	9	68	142	18	—	—	—	—	—	1	

Table 28—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Kenya	tonnes	1,178	1,674	1,059	645	—	273	—	—	—	51	—	—
	£'000	84	110	77	57	—	20	—	—	—	7	—	—
Malawi	tonnes	...	...	...	—	—	207	102	—	—	—	—	
	£'000	...	...	...	—	—	15	8	—	—	—	—	
Mozambique	tonnes	842	449	104	—	41	1,072	502	—	—	—	—	15
	£'000	63	32	8	—	3	76	38	—	—	—	—	5
Rhodesia	tonnes	4,023	2,015	476	96	—	—	—	—	—	—	—	—
	£'000	280	146	42	11	—	—	—	—	—	—	—	—
Republic of South Africa	tonnes	—	2,999	3,317	175	167	—	2,277	—	—	—	25	31
	£'000	—	196	219	12	12	—	168	—	—	—	4	5
Tanzania	tonnes	1,969	1,716	2,134	—	—	1,899	102	—	—	—	—	—
	£'000	128	113	153	—	—	131	6	—	—	—	—	—
Uganda	tonnes	51	732	—	47	51	—	—	—	—	—	—	—
	£'000	3	42	—	3	3	—	—	—	—	—	—	—
Other Countries	tonnes	681	26	205	—	9	—	—	—	4	—	—	413
	£'000	49	3	14	—	1	—	—	—	—	—	—	111

Source: *Hong Kong Trade Statistics* *Department of Commerce and Industry*

Footnotes: . . . information not available — nil or negligible

Table 29

Imports of groundnuts in-shell into Hong Kong

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	1,908	1,903	2,877	2,585	3,189	2,483	2,618	2,511	2,496	1,802	2,282	1,545
	£'000	121	122	184	176	204	201	205	222	241	212	310	278
of which from:													
Khmer Republic (Cambodia)	tonnes	20	10	–	–	–	155	20	–	–	–	–	–
	£'000	1	1	–	–	–	13	1	–	–	–	–	–
China	tonnes	45	17	443	595	859	1,320	1,310	1,051	701	1,078	1,757	939
	£'000	5	1	40	52	84	118	119	116	96	145	243	178
Indonesia	tonnes	–	206	1,187	856	1,457	90	230	319	348	104	101	92
	£'000	–	10	63	45	67	4	12	19	22	9	12	13
Republic of Korea	tonnes	51	6	–	193	–	–	–	–	–	–	–	–
	£'000	5	1	–	16	–	–	–	–	–	–	–	–
Macão	tonnes	–	8	14	7	49	–	3	–	–	–	–	–
	£'000	–	1	1	1	3	–	–	–	–	–	–	–
Malaysia	tonnes	291	133	–	3	–	–	–	–	–	–	–	–
	£'000	18	9	–	1	–	–	–	–	–	–	–	–
Vietnam Dem Rep.	tonnes	33	148	72	207	208	76	–	398	234	53	–	–
	£'000	2	9	4	12	11	4	–	26	16	3	–	–
Singapore	tonnes	–	–	–	–	–	151	405	79	333	359	352	379
	£'000	–	–	–	–	–	14	27	6	34	39	48	72
Thailand	tonnes	1,307	1,102	698	717	595	690	650	664	880	208	72	135
	£'000	80	72	43	49	37	48	46	55	73	16	7	15
Vietnam Republic	tonnes	131	123	135	–	20	–	–	–	–	–	–	–
	£'000	8	8	10	–	2	–	–	–	–	–	–	–
Mozambique	tonnes	–	102	–	–	–	–	–	–	–	–	–	–
	£'000	–	7	–	–	–	–	–	–	–	–	–	–
Republic of South Africa	tonnes	–	41	234	–	–	–	–	–	–	–	–	–
	£'000	–	1	16	–	–	–	–	–	–	–	–	–
Other Countries	tonnes	30	7	94	7	1	1	–	–	–	–	–	–
	£'000	2	2	7	–	–	–	–	–	–	–	–	–

Source: *Hong Kong Trade Statistics* *Department of Commerce and Industry*

Footnote: – nil or negligible

Table 30

Imports of groundnuts into Japan

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	3,337	9,853	18,701	25,134	37,824	30,392	49,490	43,929	59,007	52,382	62,325	76,324
	£'000	265	760	1,496	2,513	3,488	2,693	4,720	5,259	8,310	8,467	9,885	17,233
of which from:													
China	tonnes	1,243	2,473	5,047	11,788	14,643	12,315	13,738	11,465	4,773	8,749	15,727	15,427
	£'000	121	254	528	1,290	1,687	1,298	1,702	1,554	875	1,877	2,871	3,496
India	tonnes	–	–	–	–	–	–	309	805	5,480	5,104	6,178	301
	£'000	–	–	–	–	–	–	33	109	752	750	922	57
Indonesia	tonnes	–	–	43	1,018	3,114	1,117	5,266	6,990	8,834	9,525	5,324	11,961
	£'000	–	–	4	92	284	103	597	837	1,115	1,242	784	2,803
North Vietnam	tonnes	–	–	–	795	914	910	338	608	1,037	480	143	–
	£'000	–	–	–	61	85	90	36	70	132	65	20	–
Ryukyu Islands	tonnes	32	–	78	33	6	36	33	89	159	–	5	–
	£'000	4	–	10	4	1	3	5	18	39	–	1	–
Taiwan	tonnes	–	–	–	–	–	–	–	480	359	1,406	116	2,121
	£'000	–	–	–	–	–	–	–	55	46	220	21	542
Thailand	tonnes	54	126	766	1,205	922	–	840	1,125	445	190	88	330
	£'000	4	10	67	111	82	–	90	132	51	25	13	75
Vietnam Rep.	tonnes	7	–	76	1,415	2	–	–	–	–	–	–	–
	£'000	1	–	7	135	–	–	–	–	–	–	–	–
Arab Republic of Egypt	tonnes	–	–	–	–	–	–	–	–	2,484	2,398	–	389
	£'000	–	–	–	–	–	–	–	–	523	559	–	100
Malawi	tonnes	–	–	–	–	–	486	–	–	–	–	–	–
	£'000	–	–	–	–	–	35	–	–	–	–	–	–
Nigeria	tonnes	–	242	6,656	5,623	14,760	8,622	14,997	4,724	2,717	–	496	310
	£'000	–	14	445	524	1,029	575	1,063	518	289	–	57	66

Table 30—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Senegal	tonnes	–	–	1	–	–	–	73	–	1,023	–	500	–
	£'000	–	–	1	–	–	–	7	–	116	–	71	–
Republic of South Africa	tonnes	565	4,131	4,181	1,721	–	2,426	2,251	843	1,605	2,341	6,907	8,883
	£'000	39	282	304	156	–	215	205	109	202	381	1,049	1,968
Sudan	tonnes	–	–	–	493	2,125	3,567	10,807	15,249	11,465	10,766	2,263	13,254
	£'000	–	–	–	41	198	301	902	1,671	1,380	1,431	316	2,249
Tanzania	tonnes	1,363	2,368	1,484	974	671	744	838	315	981	–	–	–
	£'000	91	167	113	91	58	56	79	37	118	–	–	–
Uganda	tonnes	–	–	45	30	71	68	–	–	–	–	–	–
	£'000	–	–	3	2	5	5	–	–	–	–	–	–
Brazil	tonnes	–	–	–	–	8	–	–	1,082	10,019	3,440	666	2,228
	£'000	–	–	–	–	2	–	–	132	1,205	469	94	552
Mexico	tonnes	–	–	–	–	–	–	–	–	142	–	–	–
	£'000	–	–	–	–	–	–	–	–	33	–	–	
USA	tonnes	–	–	308	–	490	–	–	–	7,256	7,963	21,126	14,246
	£'000	–	–	13	–	52	–	–	–	1,397	1,444	3,098	3,597
Australia	tonnes	–	5	–	–	–	–	–	–	207	–	2,688	6,083
	£'000	–	1	–	–	–	–	–	–	37	–	553	1,570
Other Countries	tonnes	73	508	16	39	98	101	–	154	21	20	98	791[a]
	£'000	5	32	1	6	5	12	1	17	–	4	15	158

Source: *Trade of Japan* *Japan Tariff Association*

Footnotes: a includes 668 tonnes valued at £133,000 from Mozambique — nil or negligible

Table 31

Imports of green, groundnut kernels into Singapore (Before 1966 trade included Peninsular Malaysia)

		1966	1967	1968	1969	1970	1971	1972
TOTALS	tonnes	4,782	5,504	3,075	2,300	1,723	1,819	3,874
	£'000	413	501	318	265	194	225	512
of which from:								
Khmer Republic and Laos	tonnes	41	1,075	172	304	40	7	–
	£'000	3	90	18	33	3	–	–
China	tonnes	1,352	3,112	1,759	1,216	588	927	2,527
	£'000	144	301	191	151	83	137	339
Taiwan	tonnes	–	1	–	–	3	–	1
	£'000	–	–	–	–	5	–	–
Timor	tonnes	162	177	154	179	158	170	96
	£'000	7	12	11	13	12	12	7
Thailand	tonnes	2,683	681	196	508	600	503	106
	£'000	220	60	18	53	64	51	14
Kenya	tonnes	5	10	–	–	–	51	8
	£'000	–	1	–	–	–	6	1
Mozambique	tonnes	–	200	433	–	–	–	–
	£'000	–	15	36	–	–	–	–
Dem. Rep. of Vietnam	tonnes	255	161	202	–	–	83	–
	£'000	14	10	17	–	–	9	–
Rep. of Vietnam	tonnes	235	–	–	–	–	–	–
	£'000	19	–	–	–	–	–	–
Peninsular Malaysia	tonnes	30	71	158	93	19	72	109
	£'000	4	10	27	15	3	10	20
Other Countries	tonnes	19	16	1	–	315	6	1,027[a]
	£'000	2	2	–	–	24	–	130

Source: *External trade statistics.* *Department of Statistics, Singapore*

Footnotes: – nil or negligible. a from India

Table 32

Imports of green, groundnuts in-shell into Singapore (Before 1966 trade included Peninsular Malaysia)

		1966	1967	1968	1969	1970	1971	1972
TOTALS	tonnes	1,915	2,933	1,366	1,152	2,282	2,280	723
	£'000	120	266	125	115	162	161	80
of which from:								
Khmer Republic (Cambodia)	tonnes	–	20	–	5	–		
	£'000	–	2	–	1	–		
China	tonnes	246	2,030	548	497	154	201	264
	£'000	23	206	64	63	22	34	39
Hong Kong	tonnes	7	20	–	–	–	–	–
	£'000	1	2	–	–	–	–	–
Timor	tonnes	22	68	5	–	1	33	41
	£'000	1	3	–	–	–	2	3
Thailand	tonnes	1,275	644	563	573	363	460	155
	£'000	75	45	46	43	29	37	15
Dem. Rep. of Vietnam	tonnes	323	120	154	30	1,653	1,579	250
	£'000	18	7	8	2	97	87	21
Republic of Vietnam	tonnes	18	–	–	–	–	–	–
	£'000	1	–	–	–	–	–	–
Peninsular Malaysia	tonnes	3	10	94	47	110	7	13
	£'000	–	1	6	6	14	1	2
Other Countries	tonnes	21	1	2	–	1	–	–
	£'000	1	–	1	–	–	–	–

Source: *External trade statistics. Department of Statistics, Singapore*

Footnote: – nil or negligible.

Table 33

Imports of green groundnuts in-shell into Peninsular Malaysia

		1966	1967	1968	1969	1970	1971
TOTALS	tonnes	6,271	4,743	2,450	1,139	909	651
	£'000	396	314	138	67	52	45
of which from:							
Burma	tonnes	14	3	19	–	10	–
	£'000	1	–	–	–	–	–
China	tonnes	369	614	158	113	71	58
	£'000	32	56	14	10	5	4
Hong Kong	tonnes	62	46	–	10	–	–
	£'000	14	4	–	1	–	–
Indonesia	tonnes	164	1,167	1,991	940	743	491
	£'000	9	59	106	52	42	35
Khmer Republic	tonnes	19	41	–	–	–	–
	£'000	1	3	–	–	–	–
Thailand	tonnes	4,965	2,594	111	46	37	54
	£'000	297	175	8	3	2	3
Vietnam Dem. Rep.	tonnes	11	11	12	–	10	–
	£'000	1	1	1	–	1	–
Vietnam Republic	tonnes	627	250	148	16	32	47
	£'000	37	15	8	1	2	3
Other Countries	tonnes	40	17	11	14	6	1
	£'000	4	1	1	–	–	–

Source: *External trade statistics. Department of Statistics Malaysia.*

Footnote: – nil or negligible.

Table 34

Imports of groundnut kernels into Peninsular Malaysia

		1966	1967	1968	1969	1970	1971
TOTALS	tonnes	6,692	6,858	6,586	5,885	4,474	3,407
	£'000	559	519	498	437	326	300
of which from:							
Brunei	tonnes	39	117	88	30	19	57
	£'000	3	8	6	2	1	5
China	tonnes	660	1,106	627	523	576	508
	£'000	69	87	50	39	44	48
Hong Kong	tonnes	141	66	11	1	1	–
	£'000	21	6	1	–	–	–
Indonesia	tonnes	221	2,111	4,884	4,478	3,449	2,649
	£'000	16	146	359	315	242	229
Khmer Republic	tonnes	49	123	10	5	–	–
	£'000	4	9	1	–	–	–
Vietnam Dem. Rep.	tonnes	2	24	13	–	–	2
	£'000	–	1	1	–	–	–
Vietnam Republic	tonnes	596	405	102	14	–	–
	£'000	46	28	9	1	–	–
Thailand	tonnes	4,895	2,838	800	797	411	175
	£'000	392	227	67	76	38	17
Other Countries	tonnes	89	68	51	47	18	16
	£'000	8	7	4	4	1	1

Source: *External trade statistics.* *Department of Statistics Malaysia.*

Footnote: – nil or negligible.

Table 35

Imports of groundnut kernels into Sarawak

		1964	1965	1966	1967	1968	1969	1970
TOTALS	tonnes	616	864	793	775	707	746	757
	£'000	51	75	67	69	68	79	81
of which from:								
China	tonnes	39	38	21	50	92	62	36
	£'000	4	4	2	4	9	7	4
Hong Kong	tonnes	20	16	–	–	–	–	–
	£'000	3	2	–	–	–	–	–
Indonesia	tonnes	84	2	9	103	336	287	248
	£'000	7	2	1	8	31	15	26
Thailand	tonnes	375	658	746	582	246	356	450
	£'000	30	57	63	52	25	38	49
Vietnam Dem. Rep.	tonnes	14	25	2	–	–	–	–
	£'000	1	2	–	–	–	–	–
Vietnam Republic	tonnes	52	71	10	23	6	9	1
	£'000	4	6	1	2	1	1	–
Other Countries	tonnes	32	54	5	17	27	32	22
	£'000	2	2	–	3	2	18	2

Source: *Statistics of external trade.* *Government of Sarawak.*

Footnotes: – nil or negligible. Trade figures not available before 1964.

Table 36

Imports of groundnuts in-shell into Sarawak

		1962[a]	1963[a]	1964	1965	1966	1967	1968	1969	1970
TOTALS	tonnes	1,030	1,193	634	324	294	278	299	327	292
	£'000	84	99	52	23	19	16	20	22	19
of which from:										
China	tonnes	52	66	72	43	16	39	20	16	1
	£'000	5	7	7	4	1	2	1	2	–
Hong Kong	tonnes	23	41	20	3	–	–	–	–	–
	£'000	3	5	3	–	–	–	–	–	–
Indonesia	tonnes	142	208	17	20	53	146	179	187	144
	£'000	10	12	1	1	3	8	11	11	9
Singapore	tonnes	74	72	23	16	–	–	–	–	–
	£'000	7	7	2	1	–	–	–	–	–
Thailand	tonnes	712	778	445	134	169	88	73	104	29
	£'000	55	64	35	9	10	6	6	8	2
Vietnam Dem. Rep.	tonnes	23	19	8	34	16	–	–	4	61
	£'000	2	2	1	2	1	–	–	–	4
Vietnam Republic	tonnes	–	–	27	60	31	3	3	3	–
	£'000	–	–	3	4	2	–	–	–	–
Other Countries	tonnes	4	9	22	14	9	2	24	13	57
	£'000	2	2	–	2	2	–	2	1	4

Source: *Statistics of external trade.* *Government of Sarawak.*

Footnotes: – nil or negligible. a figures include shelled groundnuts.

Table 37

Imports of groundnuts into Australia

Figures for the year ending 30 June

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Unshelled	tonnes	...	...	3	...	770	2	224	–	439	1,456	16	
	£'000	...	...	–	...	102	–	19	–	73	209	2	
Shelled	tonnes	...	...	3,227	1,586	7,155	1,813	1,283	1,598	7,732	1,641	16,339	
	£'000	...	...	290	176	914	206	173	224	1,129	235	278	
TOTALS	tonnes	2,304	2,749	3,230	1,586	7,925	1,815	1,507	1,598	8,171	3,097	16,355	
	£'000	210	302	290	176	1,016	206	192	224	1,202	444	280	
of which from:													
China	tonnes	–	–	215	–	354	–	–	–	276	–	–	
	£'000	–	–	10	–	47	–	–	–	46	–	–	
India	tonnes	–	–	182	–	–	–	–	69	2,189	–	–	
	£'000	–	–	15	–	–	–	–	9	302	–	–	
Japan	tonnes	–	–	–	–	–	–	–	–	–	303	–	
	£'000	–	–	–	–	–	–	–	–	–	44	–	
Papua and New Guinea	tonnes	2,303	2,131	2,823	1,586	1,568	1,815	1,507	1,479	1,606	1,645	16,288	
	£'000	210	243	264	176	181	200	192	208	248	235	271	
Senegal	tonnes	–	–	–	–	–	–	–	–	391	–	–	
	£'000	–	–	–	–	–	–	–	–	69	–	–	
Taiwan	tonnes	–	–	–	–	–	–	–	–	305	–	–	
	£'000	–	–	–	–	–	–	–	–	40	–	–	
Thailand	tonnes	–	–	–	–	271	–	–	–	–	–	–	
	£'000	–	–	–	–	30	–	–	–	–	–	–	
Republic of South Africa	tonnes	–	576	–	–	–	–	–	–	2,292	–	–	
	£'000	–	55	–	–	–	–	–	–	315	–	–	

Table 37—continued

Figures for the year ending 30 June

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Tanzania	tonnes	–	–	–	–	119	–	–	–	116	–	–	
	£'000	–	–	–	–	17	–	–	–	14	–	–	
Brazil	tonnes	–	–	–	–	–	–	–	–	224	–	5	
	£'000	–	–	–	–	–	–	–	–	23	–	–	
USA	tonnes	–	–	–	–	4,814	–	–	–	273	–	–	
	£'000	–	–	–	–	645	–	–	–	54	–	–	
Other Countries	tonnes	1	42	10	–	799	–	–	50	499	1,149[a]	62	
	£'000	–	4	1	–	96	–	–	7	91	165	9	

Source: *Overseas trade.* *Commonwealth Bureau of Census and Statistics.*

Footnotes: – nil or negligible. . . . Information not available. a includes 1,141 tonnes valued at £162,000 from New Zealand.

Table 38

Imports of groundnut kernels into New Zealand

Figures for the year ending 30 June

		1962 Jan–June	1963	1964	1965	1966	1967	1968	1969	1970	1971
TOTALS	tonnes	813	2,424	2,327	2,613	2,776	1,949	2,408	3,960	3,094	2,796
	£'000	73	218	200	255	570	400	254	478	403	361
of which from:											
China	tonnes	–	–	–	30	38	10	6	12	2	1
	£'000	–	–	–	3	9	2	1	2	–	–
Hong Kong	tonnes	–	–	66	–	–	–	–	–	–	–
	£'000	–	–	6	–	–	–	–	–	–	–
India	tonnes	363	383	257	–	–	–	25	188	107	–
	£'000	28	28	22	–	–	–	2	21	16	–
Nigeria	tonnes	–	–	–	–	94	72	341	472	435	312
	£'000	–	–	–	–	18	24	26	38	48	33
Rhodesia/Malawi/Zambia	tonnes	10	35	216	...	...	...	...	...	...	–
	£'000	1	3	20	...	...	...	...	...	...	–
Malawi	tonnes	–	–	–	68	40	–	11	–	–	–
	£'000	–	–	–	5	9	–	1	–	–	–
Zambia	tonnes	–	–	–	–	18	19	25	–	–	–
	£'000	–	–	–	–	4	3	2	–	–	–
Republic of South Africa	tonnes	292	1,640	1,497	1,622	1,333	1,021	1,265	2,102	2,421	1,569
	£'000	23	142	128	152	277	213	141	264	320	197
Tanzania	tonnes	5	140	267	310	104	81	145	197	–	–
	£'000	–	12	23	29	25	16	15	22	–	–
USA	tonnes	–	–	–	399	829	690	195	–	7	–
	£'000	–	–	–	40	180	129	18	–	2	–
Australia	tonnes	125	213	–	135	7	16	377	947	78	914
	£'000	19	31	–	20	2	4	47	125	11	131
Other Countries	tonnes	18	13	24	49	313[a]	40	18	42	44	–
	£'000	2	2	1	6	46	9	1	6	6	–

Source: *External trade.* *Customs department.*

Footnotes: – nil or negligible. ... Information not available. a total includes 214 tonnes valued at £23,274 from Singapore

Table 39

Imports of groundnuts in-shell into New Zealand

Figures for the year ending 30 June

		1962 Jan–June	1963	1964	1965	1966	1967	1968	1969	1970	1971
TOTAL	tonnes	77	123	182	106	151	370	186	322	113	282
	£'000	11	11	17	10	32	72	22	41	15	39
of which from:											
China	tonnes	–	7	35	9	38	69	19	195	4	90
	£'000	–	1	4	1	9	15	3	25	1	14
India	tonnes	–	19	38	–	–	–	–	–	–	–
	£'000	–	1	3	–	–	–	–	–	–	–
Nigeria	tonnes	–	–	–	–	19	87	2	21	10	–
	£'000	–	–	–	–	3	12	–	2	1	–
Republic of South Africa	tonnes	–	71	81	41	78	176	81	58	96	80
	£'000	–	6	7	3	17	39	9	8	13	10
USA	tonnes	–	–	–	34	7	–	20	–	–	–
	£'000	–	–	–	3	2	–	2	–	–	–
Australia	tonnes	75	10	2	6	3	3	59	32	–	110
	£'000	11	1	–	1	1	1	7	5	–	14
Other Countries	tonnes	2	16	26	16	6	35	5	16	3	2
	£'000	–	2	3	2	–	5	1	1	–	1

Source: *External trade.* *Customs Department.*

Footnote: – nil or negligible.

Table 40

Imports of groundnut kernels into Algeria

		1966	1967	1968	1969	1970
TOTALS	tonnes	654	2,031	2,604	3,204	3,750
	£'000	75	197	280	384	418
of which from:						
China	tonnes	420	2,031	1,504	506	–
	£'000	49	197	174	69	–
Hong Kong	tonnes	19	–	–	–	–
	£'000	2	–	–	–	–
Arab Republic of Egypt	tonnes	–	–	500	698	297
	£'000	–	–	62	89	50
Nigeria	tonnes	–	–	–	2,000	–
	£'000	–	–	–	226	–
Rhodesia/Malawi/Zambia	tonnes	–	–	600	–	–
	£'000	–	–	44	–	–
Republic of South Africa	tonnes	212	–	–	–	–
	£'000	24	–	–	–	–
Sudan	tonnes	–	–	–	–	1,000
	£'000	–	–	–	–	86
Brazil	tonnes	–	–	–	–	2,453
	£'000	–	–	–	–	282
Other Countries	tonnes	3	–	–	–	–
	£'000	–	–	–	–	–

Source: Commerce de l'Algérie, Délégation Générale du Gouvernement en Algérie.

Footnotes: – nil or negligible. 1962–1965 information not available.

Table 41

Imports of groundnuts in-shell into Algeria

		1966	1967	1968	1969	1970
TOTALS	tonnes	4,026	3,401	2,658	5,940	8,020
	£'000	346	227	251	581	822
of which from:						
Arab Republic of Egypt	tonnes	–	–	750	1,947	901
	£'000	–	–	94	248	142
Madagascar	tonnes	66	–	400	–	–
	£'000	7	–	45	–	–
Sudan	tonnes	3,960	3,401	1,508	3,993	4,450
	£'000	339	227	112	333	392
Brazil	tonnes	–	–	–	–	2,669
	£'000	–	–	–	–	288

Source: Commerce de l'Algérie, Délégation Générale du Gouvernement en Algérie.

Footnotes: – nil or negligible. 1962–1965 information not available.

Table 42

Exports of groundnut kernels from the USA

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	7,803	16,663	36,969	76,950	59,065	77,298	54,301	24,307	47 969	105 597	176 820	178 422
	£'000	867	1,344	2,967	6,790	5,249	6,021	5,192	3,637	7,588	12 442	18 375	33 635
of which to:													
Azores	tonnes	–	–	–	–	–	–	–	–	–	–	1,050	–
	£'000	–	–	–	–	–	–	–	–	–	–	88	–
Belgium/Luxembourg	tonnes	58	105	6,388	14,009	1,684	4,983	324	–	–	684	1 874	384
	£'000	17	16	378	841	111	267	26	–	–	61	197	40
France	tonnes	8	9	289	8,097	668	579	386	–	481	788	1,216	20,312
	£'000	4	5	25	529	70	45	38	–	43	95	104	2,396
Federal Republic of Germany	tonnes	3	1,763	733	2,359	4,457	4,564	5,229	2,513	278	2,674	5,355	5,204
	£'000	1	54	44	226	403	399	496	265	22	271	552	797
Italy	tonnes	5	2	2	–	52	–	–	–	–	10,912	30,088	11,238
	£'000	3	1	1	–	5	–	–	–	–	1,035	2,711	1,537
Netherlands	tonnes	22	169	3,457	12,304	2,820	9,288	5,375	1,739	1,408	8,622	10 556	15 013
	£'000	3	21	306	1,134	246	594	526	149	168	964	1,049	3,177
Norway	tonnes	2	1	12	101	–	164	796	474	632	1,499	1,645	140
	£'000	1	–	2	10	–	15	81	76	46	194	210	38
Portugal	tonnes	–	–	–	–	2,353	1,384	–	–	–	5,831	19,793	17,141
	£'000	–	–	–	–	153	116	–	–	–	511	1,541	2,010
Spain	tonnes	1	17	230	168	458	–	–	–	–	616	2,877	2,123
	£'000	–	5	21	16	46	–	–	–	–	77	297	547
Sweden	tonnes	59	83	36	–	75	508	490	100	30	–	–	40
	£'000	13	13	16	–	6	42	45	13	10	–	–	10
Switzerland	tonnes	37	68	480	2,525	670	1,461	1,472	–	457	18,160	26,877	26,213
	£'000	9	11	46	145	49	107	138	–	67	1,987	2,832	5,213
UK	tonnes	16	17	1,556	5,244	7,699	8,676	3,612	299	1,120	2,309	10,839	9,039
	£'000	2	1	175	494	735	814	342	8	170	306	1,099	1,332

Table 42—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Czechoslovakia	tonnes	–	–	–	–	1,262	–	–	–	–	377	–	160
	£'000	–	–	–	–	124	–	–	–	–	40	–	40
Poland	tonnes	–	–	–	441	99	1,239	1,788	267	1,054	1,960	2,532	2,481
	£'000	–	–	–	43	9	97	182	37	165	246	273	526
Israel	tonnes	–	101	–	–	–	–	–	–	198	–	–	–
	£'000	–	10	–	–	–	–	–	–	36	–	–	–
Japan	tonnes	–	–	–	97	622	49	1,002	701	7,268	8,924	18,910	17,004
	£'000	–	–	–	11	66	6	57	109	1,214	1,164	2,125	3,709
Saudi Arabia	tonnes	10	8	16	–	–	–	–	–	–	–	–	–
	£'000	5	4	8	–	–	–	–	–	–	–	–	–
Arab Republic of Egypt	tonnes	9	42	4	–	–	–	–	–	–	–	–	–
	£'000	2	3	2	–	–	–	–	–	–	–	–	–
Bahamas	tonnes	6	12	12	–	–	–	–	–	–	–	–	–
	£'000	2	3	3	–	–	–	–	–	–	–	–	–
Bermuda	tonnes	27	28	19	–	–	–	–	–	–	–	–	–
	£'000	10	9	9	–	–	–	–	–	–	–	–	–
Jamaica	tonnes	1	–	3	–	–	–	–	–	280	479	552	577
	£'000	–	–	1	–	–	–	–	–	47	65	75	147
Canada	tonnes	6,748	13,372	22,960	27,521	30,197	26,978	28,306	16,367	32,960	39,096	37,369	47,229
	£'000	645	1,046	1,765	2,805	2,785	2,230	2,678	2,572	5,112	4,773	4,193	9,872
Costa Rica	tonnes	14	12	7	–	–	–	–	–	–	–	–	–
	£'000	4	3	3	–	–	–	–	–	–	–	–	–
Dominican Republic	tonnes	9	12	7	–	4,727	13,831	5,056	–	–	–	–	–
	£'000	4	2	3	–	302	944	522	–	–	–	–	–
Mexico	tonnes	18	10	17	26	–	26	–	243	77	85	–	91
	£'000	5	2	4	8	–	8	–	50	17	10	–	19

Table 42—continued

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Netherlands Antilles	tonnes	17	28	18	–	–	1,834	–	–	–	–	–	–
	£'000	8	13	8	–	–	116	–	–	–	–	–	–
Panama	tonnes	167	294	60	–	–	88	–	–	–	17	56	–
	£'000	35	45	27	–	–	5	–	–	–	5	15	–
Peru	tonnes	9	9	10	–	–	–	–	–	–	–	–	–
	£'000	5	5	5	–	–	–	–	–	–	–	–	–
Venezuela	tonnes	331	382	358	515	393	1,015	100	879	1,422	2,000	4,500	2,962
	£'000	50	46	44	70	49	165	12	254	405	558	796	1,011
Australia	tonnes	–	24	30	2,473	202	–	–	286	–	–	–	–
	£'000	–	2	15	354	27	–	–	33	–	–	–	–
New Zealand	tonnes	–	3	80	695	516	181	–	–	–	45	136	–
	£'000	–	1	8	70	49	15	–	–	–	5	14	
Other Countries	tonnes	226	92	185	375	111	450	365	439	304	564	496	1,391
	£'000	39	23	48	34	14	36	49	71	66	76	104	219

Source: *Bureau of the Census Report FT 410. Department of Commerce.*

Footnote: – nil or negligible.

Table 43

Exports of groundnuts in-shell from the USA

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
TOTALS	tonnes	291	748	4,293	1,776	1,083	334	146	363	1,125	3,522	5,407	11,018
	£'000	39	126	305	222	125	38	21	40	189	447	1,154	2,789
of which from:													
Belgium/Luxembourg	tonnes	–	18	2,817	–	–	–	–	–	–	–	–	54
	£'000	–	4	191	–	–	–	–	–	–	–	–	11
France	tonnes	–	3	1	–	–	–	–	–	–	211	113	1,006
	£'000	–	1	–	–	–	–	–	–	–	27	18	294
Republic of Ireland	tonnes	–	–	–	–	–	–	–	223	–	256	–	–
	£'000	–	–	–	–	–	–	–	18	–	21	–	–
Italy	tonnes	–	–	–	–	–	–	–	–	–	304	1,831	1,331
	£'000	–	–	–	–	–	–	–	–	–	45	116	332
Netherlands	tonnes	–	–	1,282	–	36	–	–	–	–	–	–	1,414
	£'000	–	–	86	–	7	–	–	–	–	–	–	331
Spain	tonnes	–	–	–	–	–	–	–	–	–	100	–	196
	£'000	–	–	–	–	–	–	–	–	–	14	–	58
Switzerland	tonnes	1	–	–	–	–	–	–	–	–	363	79	1,637
	£'000	–	–	–	–	–	–	–	–	–	52	18	439
UK	tonnes	1	–	41	–	.	–	–	–	–	513	–	1,145
	£'000	–	–	5	–	–	–	–	–	–	65	–	306
Bahamas	tonnes	50	60	30	–	52	37	55	–	–	–	–	–
	£'000	8	10	5	–	9	7	12	–	–	–	–	–
Venezuela	tonnes	–	–	–	–	–	11	–	–	–	–	2,973	–
	£'000	–	–	–	–	–	12	–	–	–	–	932	–
Canada	tonnes	164	549	75	214	964	182	89	98	1,050	1,700	404	2,608
	£'000	18	92	10	24	103	17	9	16	166	209	68	558
Australia	tonnes	–	–	–	1,556	30	–	–	–	–	–	–	–
	£'000	–	–	–	197	6	–	–	–	–	–	–	–
Other Countries	tonnes	76	118	47	6	1	115	2	42	75	75	7	1,627[a]
	£'000	13	19	8	1	–	2	–	6	23	14	2	460

Source: *Bureau of the Census Report. Department of Commerce.*

Footnotes: – nil or negligible. a of which 1,314 tonnes valued at £365,000 to Japan.

Table 44

Imports of groundnuts into the USSR

		1966	1967	1968	1969	1970	1971	1972	1973
TOTAL	'000 tonnes	26.8	26.6	29.6	29.0	26.8	28.0	26.9	21.0
	£'000	2,231	1,940	2,445	2,895	2,840	3,234	3,598	4,747
of which from									
China	'000 tonnes	1.0	1.0	–	–		2.0	2.0	
	£'000	83	82	–	–	. . .	199	219	
India	'000 tonnes	. . .	. . .	4.0	13.8	13.3	17.6	16.6	14.6
	£'000	. . .	. . .	331	1,610	1,685	2,149	2,081	3,650
Brazil	'000 tonnes	6.3	8.5	6.2	–	. . .	. . .	. . .	. . .
	£'000	630	716	622	–	. . .	. . .	. . .	. . .
Cameroon	'000 tonnes	0.5	2.6	4.1	2.1	2.1	1.6	3.0	. . .
	£'000	35	206	328	201	199	175	369	. . .
Arab Rep. of Egypt	'000 tonnes	0.4	2.4	2.9	–	. . .	. . .	. . .	0.6
	£'000	37	204	283	–	. . .	. . .	. . .	141
Mali	'000 tonnes	4.9	5.0	5.0	5.0	5.0	3.0	2.5	2.0
	£'000	336	212	322	435	417	309	247	298
Senegal	'000 tonnes	2.6	3.0	1.4	–	. . .	. . .	1.5	. . .
	£'000	249	284	134	–	. . .	. . .	157	. . .
Sudan	'000 tonnes	7.3	3.6	4.9	7.2	5.1	1.1	. . .	. . .
	£'000	592	229	296	533	416	150	. . .	. . .
Syria	'000 tonnes	0.5	0.3	1.0	0.9	. . .	. . .	. . .	. . .
	£'000	55	36	120	117	. . .	. . .	. . .	. . .

Source: Official Trade Returns.

Footnotes: – nil or negligible. . . . not available.

The constituent items do not add up to the total figures as the import statistics are not comprehensive.

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This report was produced by the Tropical Products Institute, a British Government organization which helps developing countries to derive greater benefit from their renewable resources.

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SUMMARY

The manufacture of animal feedstuffs in many less developed countries is often carried out with insufficient attention to quality control procedures. However, the need for good quality control may be greater in developing areas of the tropics than in developed countries due to such factors as adverse climatic conditions and greater variability in raw material composition. This report discusses the importance of quality control and indicates satisfactory procedures to ensure such control. Emphasis is placed on the need for adequate inspection, sampling and evaluation of raw materials, and for the provision of good storage conditions for both raw materials and finished products. Process control is discussed in relation to the various stages of the manufacturing process while product evaluation is also considered.

It is suggested that all feed manufacturing enterprises should undertake the more essential quality checks, whether or not they have their own laboratory facilities. Smaller enterprises are recommended to consult outside agencies while larger enterprises may decide that the cost of providing their own facilities is justified by the resultant benefits. Laboratory requirements for carrying out the various analytical procedures are described and suitable methods of feedstuffs analysis are given.

RESUME

Controle de la qualité dans l'industrie des aliments pour animaux

La fabrication des aliments pour animaux dans de nombreux pays moins développés est souvent réalisée sans accorder une attention suffisante aux procédés de contrôle de la qualité. Pourtant, un bon contrôle de la qualité peut être plus nécessaire dans des régions en voie de développement des tropiques que dans des pays développés en raison de facteurs tels que les conditions climatiques défavorables et la plus grande variabilité de la composition des matières premières. Dans ce rapport, on discute l'importance du contrôle de la qualité et on indique des procédés satisfaisants pour assurer un tel contrôle. On souligne la nécessité de procéder à une inspection, un échantillonnage et une évaluation appropriés des matières premières et d'assurer des conditions satisfaisantes de stockage à la fois pour les matières premières et les produits finis' Le processus de contrôle est discuté en liaison avec les divers stades de la fabrication, tandis que l'évaluation du produit est également prise en considération'

On suggère que toutes les entreprises fabriquant des aliments devraient entreprendre les vérifications de qualité les plus importantes, qu'elles aient ou non leurs propres installations de laboratoire. On recommande aux petites entreprises de s'adresser à l'extérieur, alors que les grandes entreprises peuvent décider que la dépense pour

assurer leurs propres installations est justifiée par les profits qui en résultent. On décrit les équipements de laboratoire nécessaires pour les divers procédés d'analyse et on indique les méthodes appropriées d'analyse des aliments.

RESUMEN

Control de calidad en la industria de productos para la alimentacion animal

La fabricación de productos para la alimentación animal, en los países menos desarrollados, se realiza a menudo prestando insuficiente atención a los procesos de control de calidad. Sin embargo, la necesidad de un buen control de calidad puede ser mayor en las zonas tropicales en vías de desarrollo que en los países desarrollados debido a factores tales como las condiciones climatológicas adversas y una mayor variabilidad en la composición de las materias primas. Este informe trata de la importancia del control de calidad e indica procedimientos satisfactorios para asegurar tal control. Se subraya la necesidad de una inspección, muestreo y evaluación adecuados de las materias primas, así como la de disponer de buenas condiciones de almacenamiento tanto para las materias primas como para los productos acabados. Se discute el control del proceso en las distintas etapas de fabricación, considerándose también la evaluación del producto final.

Se sugiere que todas las industrias de productos para la alimentación animal emprendan los controles de calidad más esenciales, tanto dispongan o no de laboratorios propios. Se recomienda a las empresas pequeñas que recurran a servicios externos, mientras que las empresas de mayor volumen pueden decidir la instalación de servicios propios siempre que el costo de los mismos esté justificado por los beneficios resultantes. Se describen las instalaciones de laboratorios necesarias para realizar los distintos procesos analíticos y se exponen los métodos aconsejables para el análisis de productos alimenticios.

Chapter 1

Introduction

PURPOSE OF THE REPORT

The world demand for meat and to a lesser extent eggs and dairy products is increasing steadily as population rises and as higher living standards are sought, both in the more affluent societies of the developed world and in many less developed countries. Increased production to meet this demand can be achieved only if adequate supplies of animal feeds of the right nutritive value are available. It is therefore of vital importance both to step up production of such feeds and to ensure that they are properly conserved and used.

Pressures on existing supplies have led to the establishment of enterprises to breed animals – particularly poultry and pigs – using modern intensive production methods which, in turn, depend for their success on sufficient feed supplies. Accordingly, in most developing countries, small manufacturing enterprises have been set up to produce pig and poultry feeds. However, they often operate under much more difficult conditions than in developed countries, frequently facing great problems in obtaining enough raw materials. Their choice is, for example, restricted largely to the feeds which are produced locally since governments are understandably reluctant to permit the expenditure of scarce foreign exchange on importing feed materials. Prices and availability of such raw materials may be subject to large seasonal variations while quality is also likely to vary widely. A close watch also needs to be kept on the quality of those raw materials which must be imported, as their purchase may well have been arranged through agents with little experience of the world feed market.

It will be seen that good quality control of both raw materials and finished products is even more necessary for feed manufacturers in the less developed countries than for their counterparts in the developed world. At present, however, such control in developing countries is usually either very rudimentary or non-existent. This is due to a combination of factors such as small scale of operation, failure by management to understand the need for quality control, lack of experienced, qualified staff and laboratory facilities, and lack of legislation on the composition, description and marketing of manufactured feeds. The purpose of this publication is to explain why quality control is important for feed manufacturing and marketing enterprises, however small, and to describe the procedures by which it can be best carried out.

THE MEANING OF QUALITY CONTROL

Quality control is a way of ensuring that purchased raw materials are of good quality and, where applicable, meet contract specifications. It is also necessary in determining the precise composition of raw materials and the levels of toxic substances (if any) normally present, e.g. gossypol in cottonseed cake or aflatoxin in groundnut cake, so that mixed feeds of the required nutritive value can be safely

prepared from them. Checks of this kind show whether materials which are not to be used immediately can be stored without risk of deterioration and whether the products are of the required quality.

Although quality control adds to production costs it also brings increased economic benefits. It can indeed often be justified in terms of the savings of raw materials alone, savings which arise from the more efficient use of raw materials and the prevention of losses during storage. However, perhaps its most important purpose is to provide the customer with feed of the required and stable quality so that he will repeat his orders. Even when, as in many less developed countries, competition from other manufacturers is lacking, it is essential to supply reliable feeds of good quality if the market is to be maintained or expanded.

QUALITY CONTROL IN DEVELOPED AND DEVELOPING COUNTRIES

Feed enterprises in developed countries in general operate on a much larger scale than their counterparts in the developing world. They often maintain small laboratories at the individual feed mills to carry out simpler routine tests, while the more difficult analyses and formulation work are undertaken by a larger central laboratory, which also controls the technical performance of the mill laboratories. This type of central organisation is clearly not economically possible for small enterprises in developing countries which may consist of as little as one mill. Mills in developed countries also tend to be larger than those in developing countries and nowadays rarely have a capacity of less than 50 000 tonnes of finished feed per annum. Such small mills as do operate on an individual basis in developed countries often have no quality control facilities at all, and rely on obtaining their raw materials from suppliers of good repute. They may also make use of the quality control facilities of their suppliers of premix materials to investigate specific problems which may arise.

All feed manufacturing enterprises, however small, in developing countries need access to quality control facilities if they are to operate efficiently. For the larger multi-mill enterprises it may be possible to have laboratories at each mill coupled with central analytical facilities (perhaps one mill laboratory would be enlarged to handle this), or a single laboratory to service all the mills. The larger single mill operators might also be able to maintain a small laboratory but will need to supplement this as necessary by recourse to government or university advisory services and perhaps the technical services of their suppliers of vitamins/mineral mixes and medicaments. The very small enterprises operating a single mill will almost certainly be unable to maintain a laboratory at all, and will have to rely entirely on the good sense and experience of the management (especially the raw material buyer and the production manager) and such facilities as are available from government or university advisory services or raw material suppliers. However, there are some procedures which can be carried out by the mill management itself, even in the absence of a mill laboratory.

MAKING QUALITY CONTROL EFFECTIVE

Quality control can only be effective if its importance is fully realised by all employees of the feed production enterprise from the top management downwards.

The raw material buyer must ensure that anticipated quality as well as price is taken into consideration when purchasing contracts are entered into and materials must be carefully examined when they are received at the factory. Management must respond positively to any complaints by customers regarding feed quality and must not be afraid to spend money on investigating them properly.

LEGISLATION ON FEED DESCRIPTION AND QUALITY

Most developed countries have comprehensive legislation controlling the composition, description and marketing of animal feeds, and it is a major function of quality control to ensure that this is complied with, especially with regard to the composition of mixed feeds. Legislation may be enacted for the following purposes:—

1. To protect the purchasers of mixed feeds from fraud, by laying down regulations for the description and testing of feeds. Such regulations normally specify the information which must be given to the customer with regard to the nutritive value and nature of the feed, and lay down procedures for ensuring that feeds meet their stated specifications.
2. To restrict the presence of substances in feeds which could be harmful to persons eating the products of animals which had consumed the feed. Regulations in this regard relate to naturally occurring toxic constituents of feeds, growth-promoting additives and medicaments.
3. To ensure that the feed is appropriate in composition and nutritive value for the particular class of animal for which it is intended. For example, if a feed is described as a poultry starter feed, it should be of sufficient nutritive value and acceptability to produce a satisfactory rate of growth and efficiency of feed conversion in chicks. Such requirements are met by laying down minimum requirements for the nutritive value of feeds marketed for consumption by different classes of animals.

In general, it is more usual to legislate with regard to (1) and (2) than (3), as it is considered, in developed countries at least, that provided the feed is accurately described in terms of nutritive value and composition, it is a matter for the customer and supplier to decide if it is appropriate for the intended purpose. However, in some developing country situations it may be desirable to have some official safeguards for the minimum nutritive value and composition of feeds which are labelled for consumption by particular classes of animals. These safeguards may be obtained by legislation or more usually by a voluntary standardisation procedure, under which feeds may be labelled as being formulated to a particular standard established by a national standards organisation. This latter approach has the advantage of greater flexibility, as standards can be up-dated more rapidly than legislation.

Only a few developing countries have so far enacted legislation on animal feeds, but there is a growing awareness of the need for this, and it is likely that feed manufacturing enterprises in developing countries will increasingly have to take such legislation into account. Compliance with regulations on feed composition or effective participation in standardisation schemes cannot be assured unless proper quality control is carried out.

Obviously, the exact nature of legislation and standardisation schemes will depend very much on the local conditions within the country concerned. However, a short bibliography of some examples of legislation on animal feeds and standards for use in certain developing countries is given in Appendix 1 of this publication. These should serve as a guide to any country wishing to take action on these lines.

Chapter 2

Raw materials

TYPES OF RAW MATERIALS USED

Farm animals require adequate supplies of energy, protein and essential vitamins and minerals for maintenance and production. It is also often desirable to include various synthetic medicaments and growth promoters to reduce the effect of disease on production and to improve feed conversion.

Raw materials used to make compound feeds can be classified on the basis of their likely contributions to the finished feed. Materials which are included for their energy contribution include cereals, cereal milling by-products, molasses and dried cassava; oilseed cakes and meals; fishmeal, and abattoir by-products are the most important sources of protein. Minerals may be supplied by bonemeal or proprietary mineral supplements, while leaf meals and proprietary vitamin mixes can be used to add essential vitamins to compounded feeds. Further details of the composition and properties of the raw materials normally used for feed manufacture are given in "The Small Scale Manufacture of Animal Feed", (Palmer-Jones & Halliday, 1971).

FEED FORMULATION

There are a number of factors which have to be borne in mind when assessing the suitability of various raw materials as ingredients of compound feeds, the first and probably the most important being that of protein and energy content in relation to price. The quality of protein and the mineral and vitamin contents must also be considered in addition to, in certain cases, the presence of substances which may limit usage e.g. excessive fibre, toxic substances, or components which may result in low palatability. The likely effects of raw materials on the physical and keeping properties of finished products, and the possibility of some materials causing difficulties in the manufacturing process must also be taken into account.

Obviously, the simplest way for a feed manufacturing enterprise to avoid these problems is to use only 'safe' materials of the highest quality. However, there is constant pressure on feed manufacturers to keep their products as cheap as possible, and this necessitates a more adventurous approach to raw material selection. Moreover, feed manufacturers operating in developing countries generally have only a restricted range of raw materials of variable quality available to them and have to make the best of situations which are often unsatisfactory.

Most feeds are nowadays formulated with the assistance of a computer, which calculates the cheapest product obtainable from available raw materials within constraints laid down for the nutritive value, toxicity and palatability of the final product. In the developed countries it is usual for the large feed manufacturers to maintain a computer service for their various manufacturing units and also for their customers buying protein concentrate/vitamin/mineral mixes. It is now

common practice for manufacturers in developing countries to make use of the services of their suppliers of vitamin/mineral mixes in developed countries.

Quality control of raw materials is in the first instance designed to ensure that they meet minimum contract specifications, that they are suitable for inclusion in the final products, and also to indicate the maximum proportions in which they can be included. A second and equally important purpose is to provide the information required to produce least cost formulations. It is realised, however, that the smaller enterprises producing a limited range of products will not need to revise formulations very often. Also if only a small range of raw materials is available it may be possible to formulate least-cost diets without access to a computer.

PRELIMINARY INSPECTION

The first essential in any mill, however small, is to ensure that materials are given a thorough physical inspection when they are received at the mill. They should be looked at carefully for evidence of wetting, the presence of deleterious substances such as stones and dirt or other materials, and of storage pests. Evidence of damage which has previously occurred should be noted. The moisture content of cereals should be determined by one of the rapid procedures which are commercially available, and any consignment containing more than 13 per cent moisture should not be taken into store until after drying. This preliminary inspection is a vital part of raw material quality control and will in fact be the only regular type of control possible for the very smallest scale of enterprise. It is essential, therefore, that the inspection be carried out very thoroughly by a properly trained and responsible member of staff, and that it should not be left to lower grade personnel such as foremen of labour gangs.

SAMPLING

The next stage in quality control is that of the drawing of a sample for analysis in the laboratory. Sampling should be carried out very carefully as there is little point in analysing materials in the laboratory if the results obtained do not give an adequate representation of the composition of the whole material from which the sample was drawn.

For most materials the procedure currently used in Great Britain to meet legislative requirements (Ministry of Agriculture, Fisheries and Food, 1973) is quite adequate for quality control purposes. Small seeds such as cereals or finely divided materials should be sampled in one of two ways depending on whether they are received in bags or in bulk.

Samples should be taken from material in bags as representatively as possible using a sampling spear or by opening them and removing a small portion. The number of bags from which samples should be taken depends on the size of the consignment:

Size of consignment	*Percentage of bags to be sampled*
2 – 20 bags	20%
20 – 60 bags	10%
60 – 200 bags	7%
200 – 500 bags	5%
500 – 1000 bags	4%
More than 1000 bags	3%

Samples of less than 100 kg consisting of as little as one bag should be sampled so as to produce as representative a sample as possible weighing at least 0.75 kg.

Similar materials received in bulk require samples to be taken in accordance with the size of the consignment as specified below:—

Size of Consignment	*Number of Samples*
Less than 1 tonne (t)	4
1 – 2 t	6
2 – 5 t	10
5 – 10 t	15
10 – 25 t	25
25 – 50 t	40
50 – 100 t	60
For each additional 10 t in excess of 100 t	2

The samples taken either from individual bags or from different portions of the bulk consignment should be bulked together, thoroughly mixed and reduced in size by quartering or using a sample divider, to between 1 and 2 kg in weight.

Very coarse materials such as oilcakes require a slightly different sampling procedure, in which pieces are selected from different parts of the whole quantity as follows:—

Size of Consignment	*Number of Pieces*
Less than 2 t	5
2 – 5 t	10
5 – 50 t	15
50 – 100 t	25
For each additional 20 t in excess of 100	2

The pieces selected should be ground, thoroughly mixed and the sample reduced in size to between 1 and 2 kg as outlined above.

Liquids in drums e.g. molasses, should be sampled in accordance with the plan for bagged consignments, outlined above. Bulk tanker deliveries of molasses can be sampled by removing portions from the top, middle and bottom of the tank. The samples taken from individual drums or tanks should be thoroughly mixed and reduced in size to 1 to 2 kg if necessary.

TESTS REQUIRED FOR ALL MATERIALS

With the exception of certain materials such as vitamin/mineral mixes all raw materials are likely to make some contribution, however small, to both the protein and energy content of the final product. It is, therefore, usual to carry out a 'Weende' proximate analysis on most materials to determine the moisture, crude protein, oil, crude fibre, ash (mineral matter) and nitrogen-free extract content of the material, by the methods given in Appendix 2. Proximate composition indicates possible constraints on usage due to the presence of excessive content of cellulosic material, oil or mineral matter.

Additional tests should be carried out on materials with high ash contents, to determine the proportions of ash soluble and insoluble in acid (see Appendix 2). The amount of acid insoluble ash is a good guide to the amount of sand or other dirt which may be present. It is also desirable to determine the free fatty acid content (rancidity) of oily materials (see Appendix 2) as this will affect palatability.

None of these tests require any very specialised equipment to carry out, and the aim should be to ensure that feed mills with laboratories should carry them out as a matter of routine. The very small production enterprises without laboratory

facilities should try to have proximate analyses of their raw materials carried out from time to time by other organisations e.g. government or university laboratories, or by suppliers of vitamin mineral mixes to check that composition is in line with that normally expected.

In some cases where proximate analysis of all consignments of raw materials is not possible, it will be necessary to make allowances in formulations for possible variations in raw material composition. If the production of a finished feed of the minimum nutritive value specified is to be assured, it will be necessary to formulate on the basis of the worst raw material composition anticipated in terms of nutritive value. This will inevitably raise the cost of the products.

TESTS FOR PROTEIN QUALITY

When formulating feeds for pigs and poultry it is necessary to take into account amino acid pattern as well as total protein content. Determination of amino acid content is a lengthy and complicated process requiring highly specialised equipment and only the very large feed enterprises could consider doing this on a regular basis. However, amino acid compositions of the proteins of cereals and protein concentrates used for animal feed do not vary too widely and it is possible to work largely from standard tables. But there is a vital exception, that of lysine. This is because damage to proteins during processing or subsequent storage can render a proportion of lysine nutritionally unavailable, and it is therefore particularly dangerous to rely on figures for total lysine given in compositional tables. These suggest that all amino acids are fully available but this is not always the case, and lysine, in particular, may have a low availability. Determination of 'available' lysine must be carried out on a regular basis for protein concentrates intended for inclusion in pig and poultry feeds. The services of a large central laboratory or of some outside analytical service will therefore be needed rather than those of a mill laboratory. Lysine availability is particularly critical for animal protein concentrates such as fish or meat meal which are often major sources of lysine in mixed feeds. The key to obtaining materials with high available lysine contents lies with the choice of supplier, and the importance of quality must be impressed on him. In particular, attention should be drawn to the need for processing temperatures to be kept to the minimum necessary to achieve sterilisation, and for good storage conditions before despatch to the mill.

TOXIC SUBSTANCES

Some materials used as sources of animal feed contain 'endogenous' toxic substances which may at low concentration adversely affect feed conversion and palatability, and, at higher concentration, even result in the death of animals. Examples of these endogenous toxins include gossypol in cotton-seed, glucosinolates in rapeseed, and cyanogenetic glycosides (liberating hydrogen cyanide) in linseed and cassava. Much of this natural toxicity can be eliminated during processing of the feed raw material e.g. oil cake or meal, or dried cassava chips, and it is important that some idea be obtained of the 'normal' levels of toxicity which may be expected. Obviously it will not be practicable to assess toxicity on a routine basis but this should certainly be done initially to establish the best source of supply and then from time to time. Suitable methods of analysis are given in Appendix 2, but it is realised that only the larger enterprises could consider carrying out the analyses themselves, and outside assistance would probably be needed.

Some oilseeds and pulses contain proteins which adversely affect feed conversion efficiency, the best known being those in soya beans. Such proteins are inactivated by heating, and problems are only likely to arise with unprocessed materials and extracted meals. Heating affects the activity of enzymes which are naturally present and this forms the basis of the well-known 'urease' test for soya meal, (see Appendix 2). It is not really practicable to carry out tests for residual

enzymic activity except for the very large feed production enterprises, and if soya meal is to be used it is better to ensure that a reputable supplier is used.

Another group of toxic substances which may be present in feed materials are those formed by moulds. Of these mycotoxins only aflatoxin, produced by the mould *Aspergillus flavus,* need normally be considered, although mycotoxins produced by other fungi such as *Fusarium* may sometimes cause trouble. Aflatoxin is liable to be present on any materials produced and stored under hot and humid conditions but is found particularly in groundnut cake, palm kernel cake, coconut cake and maize which has not been dried properly after harvest. It is probably wise to test as far as possible all consignments of the above-mentioned oilseed cakes, and meals as a routine by the rapid method described in Appendix 2. Other materials which have evidence of mould damage should also be tested for aflatoxin. Simple aflatoxin analysis may be carried out in small mill laboratories.

Tests for toxic substances are of greater importance when the materials are to be included in pig, poultry, calf or lamb feeds. Mature ruminants are less affected by the toxins mentioned above and routine tests are not strictly necessary for dairy, beef or sheep feeds.

MOLASSES

Special tests must be carried out on molasses to determine total sugar content. This may be determined either chemically or estimated by physical measurements (see Appendix 2). Molasses also contains undesirably high amounts of potassium, and potassium content requires checking from time to time (see Appendix 2). Molasses from particular sugar mills does not vary widely in composition and unless fraud is suspected checks do not need to be made unless there is a change in sources of supply. Analysis of molasses is best carried out in a central rather than a mill laboratory.

MINERALS

Minerals in compound feeds are largely supplied in the form of special proprietary mineral mixes, and provided a reputable supplier is obtained there should be no need to check these. Other sources of minerals include bone meal (and meat and bone meal) and materials such as oyster shell and ground limestone, particularly necessary for poultry layer rations. Any materials of this nature included as sources of calcium or phosphorus (or both) should be analysed from time to time, particularly when decisions are to be taken regarding new sources of supply. Calcium and phosphorus are best determined in larger central laboratories but can be determined if necessary in mill laboratories (see Appendix 2).

VITAMINS

Vitamins are nowadays mainly supplied by the inclusion of special vitamin mixes (or vitamin mineral mixes) in compound feeds. The choice of a reputable supplier and adequate care regarding storage conditions should be sufficient for such mixes. Important natural sources of vitamins include milling offals such as wheat bran and leaf meals, leaf meals also acting as sources of colouring matter for eggs and poultry meal.

It is desirable to check the carotene content of leaf meals from time to time as quality can be very variable. This analysis is best carried out in central laboratories by the method given in Appendix 2. The quality of leaf meals is very dependent on care taken in processing and once a reliable supplier and seasonal

variations in composition are identified there should not be too many problems. If supplies of reliable quality leaf meal are not locally obtainable, it is probably better to rely on vitamin mixes and synthetic colouring matters.

MEDICAMENTS

Only the very largest feed manufacturing enterprises will want to test the potency of medicaments. In general it is best to identify reliable suppliers and to rely on them.

Chapter 3

Storage of raw materials and finished products

THE NEED FOR GOOD STORAGE

Both raw materials and finished feeds are liable to deteriorate in quality during storage unless precautions are taken. Reduced quality in raw materials results in direct economic loss by decreasing their nutritive value, while finished products may have their palatability and nutritive value reduced below minimum specifications, and become less attractive in appearance.

The environment in which feeds are stored is of vital importance in determining the type and extent of changes which may occur. The most important environmental factors are ambient temperature and humidity, which greatly influence the rate at which chemical changes take place, and the growth of pests such as fungi and insects. Certain chemical changes which occur in stored feed are closely related to the activity of fungi and insects and it is difficult to consider these factors in complete isolation.

Obviously climate is the main factor controlling environmental conditions and it is unfortunate that high temperatures and relative humidities which increase the likelihood of deterioration in storage occur more widely in the developing than the developed countries. As a general rule it is better not to attempt to store finished products in the less developed countries for long periods as, however carefully storage conditions may be controlled, there is always some danger of marketing a product of below minimum specifications. This is particularly so for non-ruminant feed where vitamins and drug potencies may be of importance. As far as possible, therefore, feed should be produced in accordance with current market demand.

Due to seasonal fluctuations in availability and price, it is often necessary to maintain fairly large stocks of raw materials at feed enterprises in developing countries if market demand for finished feeds is to be continuously satisfied at suitable price levels. It is often desirable to carry three or more months supply of most locally produced raw materials, while materials which have to be imported may have to be stored for longer periods due to infrequency of supply.

MOISTURE CONTENT

If raw materials are to be stored safely it is of great importance that they be at a 'safe' moisture content level and free from infestation by pests when they are brought into store. The term 'safe' is generally taken to mean a moisture content at which it is not possible for moulds to grow, but materials with moisture contents below the minimum at which mould growth can occur are still liable to attack by insect pests. The relationship of moisture content to pest activity is best expressed in terms of the atmospheric relative humidity with which the moisture in the material is in equilibrium. Oil-free materials, such as cereals, have higher moisture contents than those containing oil when in equilibrium with the

same relative humidity. However, differences in moisture content/relative humidity relationships are small for oil-free materials and it is possible to correlate these to some extent with the types of biological activity which are possible at different moisture contents. Moisture content in equilibrium with a given relative humidity varies with temperature and for a 10° rise decreases by 0.6 – 0.7 per cent for oil-free materials.

The relationship between moisture content and possible biological activity for an oil-free material at temperatures of 20 – 30°C is given below:

1. Up to 8 per cent moisture (30 per cent relative humidity): no significant biological activity.
2. 8 – 14 per cent moisture (30 – 70 per cent relative humidity): insect infestation possible.
3. 14 – 20 per cent moisture (70 – 90 per cent relative humidity): insect infestation and mould growth possible.
4. 20 – 25 per cent moisture (90 – 95 per cent relative humidity): insect infestation, and mould and bacterial growth possible.
5. Above 25 per cent moisture (more than 95 per cent relative humidity): bacterial growth and seed germination possible.

In practical terms this means that moisture content should be kept as low as possible but in any case should not be allowed to exceed that in equilibrium with relative humidities of 70 per cent or more. If one allows a safety margin to take into account small differences between materials and temperature, a maximum moisture content of 13 per cent for materials which are substantially oil-free, e.g. cereal and extracted meals, would seem appropriate. This figure should be reduced by about 1 per cent moisture for each 5 per cent of oil contained in the material e.g. the 'safe' moisture content for groundnut cake containing 5 per cent oil would be 12 per cent. Moisture content can also influence the degree to which chemical changes which are not biologically induced may occur, but its greatest effect is on the biological changes given above.

TEMPERATURE

Temperature also influences changes in quality of feed materials by affecting the level of biological activity and the rate of chemical change. The degree of biological activity is enhanced as temperature rises to an optimum level after which it decreases. The optimum range for maximum fungal activity is 35–40°C while insects cannot normally survive at temperatures above 40°C.

Uneven temperature distribution caused by poorly constructed stores or localised biological activity can intensify changes in stored materials. Convection currents may be set up which cause pockets of the material to become excessively moist. In addition condensation of moisture at the surface of a mass of feed which is at a temperature higher than the ambient may cause similar problems.

PREVENTION OF LOSSES DURING STORAGE

To prevent deterioration of stored raw materials and finished feeds it is essential to keep them as cool and dry as possible and to prevent or minimise infestation by insect and rodent pests. Accordingly, the construction and layout of the storage facilities are of great importance. Storage warehouses should be so constructed that micro-climatic variations within them will be significantly reduced, compared to ambient conditions, and condensation, insect infestation and mould growth are consequently lessened. Concrete structures are most suitable: walls and roofs should be moisture proof, a system for controlled ventilation should be

included and the whole structure should be rodent proof. Separate areas should be included for raw materials and finished products, and these should be further separated from the processing area; this will help to simplify disinfestation procedures.

Proper management must be exercised over storage and should include regular inspection checks of both incoming and stored materials, and good hygiene measures. The vital importance of the moisture content and incidence of insect infestation of raw materials when they are brought into store has already been mentioned. It is necessary, therefore, to check the moisture content of all consignments before they are accepted into store and to inspect them carefully to see if any insect infestation is present. There are a number of reliable methods available for determination of moisture content which can be used on a routine basis and there are standard procedures for assessing the level of insect infestation (Ashman, 1973). If excessive moisture levels are detected the consignment should be either rejected or dried to the 'safe' level for the particular commodity as indicated above. Infested materials should be fumigated using, for example, methyl bromide or phosphine (Thompson, 1966). Materials in store should also be inspected regularly and treated if necessary. In certain cases, such as bulk stored cereals, cooling with low volume ambient air systems can prevent insect pests from multiplying and so will eliminate the need for insecticides. Certain raw materials require particular care in storage; they may be expensive and/or highly susceptible to loss in nutritive value. High storage temperatures can reduce protein quality in protein concentrates, particularly fishmeal, by making lysine less available, and it is essential to keep these as cool as possible. Vitamin mixes and medicaments can lose their potency when stored at high temperature, and in countries with high ambient temperatures it may be necessary to provide cooled storage facilities.

Chapter 4

Process control

Having established the composition of raw materials and worked out appropriate product formulations, the next stage is that of manufacture. However, before this it is important to ensure that raw material stocks are rotated properly and that the materials in stock longest are used first. This is of greatest importance in the case of materials which are to be included as major sources of vitamins and medicaments, and which could well suffer serious losses in potency during prolonged storage, but the same principle should as far as possible be applied to all raw materials.

While the analytical chemist has some role to play in process control, the major responsibilities lie with the mill management and the staff directly responsible for operating the plant. Basic plant design and lay-out will also have a major bearing on the ability of the mill to produce feeds of the required quality. It cannot be emphasised too strongly that unless feed mills are managed properly and that staff of adequate ability are employed on the various manufacturing processes, there can be little likelihood of products of consistent quality being produced.

The manufacturing process can be divided into four stages, viz grinding (if necessary); weighing and blending of the respective ingredients; mixing of the ingredients, and pelleting (if required), each of which requires to be controlled very carefully if feeds of the appropriate composition and quality are to be produced.

GRINDING

Grinding may be carried out before or after mixing. The fineness of grind has a greater bearing on subsequent processes in the feedmill than on nutritional value. For pelleting operations it is desirable to have a finely ground material, while particle size range is important in affecting mixing characteristics. Sieving tests to determine particle size range should be carried out regularly in order to check that the feed is being ground to the required degree of fineness and that no material is escaping the grinding process.

Grinding before mixing presents no problem but if it is carried out afterwards care should be taken to ensure that materials of a very fine nature, such as synthetic amino acids or medicaments, are not lost via air separation systems or dust extractors. Protected vitamins in the form of micro-capsules may show a reduced potency after grinding but this would only be a serious problem if grinding was very fine.

WEIGHING AND BLENDING

Weighing and blending, together with mixing, are probably the most important procedures in the production of compound feeds. It is important therefore that the critical nature of these procedures should be recognised and that they should be carried out by staff of appropriate skill and status.

The weighing and blending of the bulk ingredients, cereals and protein concentrates, presents no difficulties and in modern plants may be completely automated. However, great care is necessary in the case of micro-ingredients such as vitamins, trace minerals and medicaments which have to be added manually in very small quantities. The additives for a particular feed may be purchased in pre-mixed form as a complete supplement or else purchased separately and then blended. In either case they should be pre-mixed with enough suitable ground cereal to make up at least 5% of the main mix. Equipment suitable for accurately weighing and dispensing small quantities of ingredients should be provided and micro-ingredients should be clearly labelled. Usage rates and precautions for drugs should be displayed and an accurate stock control system should be maintained to provide rapid evidence of possible over or under-usage of micro-ingredients. Care should be taken to minimise carry-over of material from one batch to the next.

MIXING

Mixing efficiency will vary considerably with the types of feed being produced. In general it is more difficult to obtain feeds of the required homogeneity when it is necessary to include additives at low concentration levels. When new plants are commissioned or new feeds are produced it is essential to establish the optimum mixing time for the achievement of adequate homogeneity. The manufacturers of the mixing plant will be able to advise on this optimum mixing time but it is desirable that tests should be carried out under actual operating conditions. For this purpose at least five samples should be taken from each batch. The samples which should be of a weight equivalent to the expected daily intake of the animals for which the feed is intended, should then be analysed for content of a micro-ingredient for which an accurate method of assay is available. Alternatively a tracer e.g. a dye may be added. For methods to establish homogeneity of mixing see Headley (1967). Once the optimum time of mixing has been established this should be rigidly adhered to.

PELLETING

Pelleting is normally carried out after treatment of the mixed meal with steam to increase temperature and moisture content. Pellets must then be cooled and dried down to a safe moisture content as rapidly as possible after formation, by treatment with cooling air. Failure to carry out pelleting operations properly may result in loss of nutrients such as added vitamins, and it is essential that close control be exercised over this operation. In particular it is desirable to check from time to time the moisture content of the meal before and after steaming to ensure that optimum conditions are achieved. Anticipated losses in micronutrients and medicaments during pelleting may be allowed for by increasing amounts included.

Chapter 5

Product quality control

PURPOSE AND NEED FOR PRODUCT QUALITY CONTROL

Quality control on products is carried out to check that the manufacturing process is functioning properly and that the products meet the specifications laid down for them. If (a) proper quality control is carried out on the raw materials and (b) process control is adequate, no quality control of the final product should be necessary. In any case there is normally very little time between production and sale for analysing samples and assessing results.

Nevertheless raw material quality control is rarely perfect and things do go wrong from time to time during manufacture, so some product quality control is highly desirable, especially for those feeds with more exacting specifications.

TYPES OF PRODUCTS

Product quality control procedures depend very much on the nature of the feed being produced, and it would, therefore, be useful to summarise the main types of compounded feeds produced by feed mills. These are as follows:—

1. Feeds for Poultry, Ducks and Turkeys
   - (a) Starter Feeds: these are fed for the first 6–8 weeks after hatching to birds it is intended to rear to maturity.
   - (b) Grower Feeds: birds are placed on these from starter feeds until they reach 16–18 weeks.
   - (c) Breeder (Layer): Feeds for mature birds over 16–18 weeks old retained for egg production.
   - (d) Broiler Feeds: these are to produce maximum weight gains until 9 weeks after hatching. Broiler feeds normally consist of starters for birds up to 5 weeks after hatching, and finishers for those of 5 weeks and over.

2. Feed for Pigs
   - (a) Starter Feeds: for early weaned piglets (2–3 weeks old)
   - (b) Creep Feeds: supplementing feeds for piglets until they are fully weaned.
   - (c) Feeds for lactating sows and weaners.
   - (d) Growing feeds for pigs up to 50–60 kg liveweight.
   - (e) Bacon feeds for pigs above 50–60 kg liveweight.
   - (f) Final fattening feeds.
   - (g) Special feeds for pregnant sows.

3. Cattle and Sheep Feeds

(a) Milk Replacers: for early weaned dairy calves.
(b) Calf Feeds: supplementary feeds for calves.
(c) Dairy Feeds: concentrate feeds for milk production.
(d) Beef Production Feeds: concentrate feeds for beef production.
(e) Lamb Creep Feeds: supplementary feeds for lambs before they are fully weaned.
(f) Sheep Production Feeds: concentrate feeds for sheep.

There is likely to be local demand for other types of products e.g. feeds for horses, rabbits, work animals (oxen and buffalo) but the above-listed products are likely to constitute the main output of most feed mills in the developed countries. In developing countries the major demand is likely to be for poultry and dairy feeds, the use of concentrates for beef and lamb/mutton production being very small, and religious considerations often limiting the demand for pork.

SAMPLING OF PRODUCTS

In general product sampling need not be quite as rigorous as for raw materials. Products containing micro-ingredients which have a major bearing on animal production e.g. poultry feeds and feeds for immature pigs require particular attention, however, and normally a sampling of 1% of bags of feed produced in a single production run is required. Other materials such as ruminant feeds and feeds for mature pigs do not require such rigorous sampling and a sample from as little as 0.1% of bags per production run is adequate. Samples taken in single production runs should be bulked and reduced in size to that appropriate for a laboratory examination.

LABORATORY EXAMINATION OF SAMPLES

Laboratory examination of samples of products has a twofold objective. Firstly, it is obviously desirable to monitor the nutritive value of products to ensure that they are of the required quality; secondly, it is necessary to have some check on the manufacturing process to ensure that operations are carried out properly. As already emphasised, however, products are unlikely to be regularly tested before they are sold, and product quality is almost entirely dependent on the effectiveness of raw material quality and process control. It should also be mentioned that the need for product quality control may also be affected by national legislation regulating feed quality and description.

It is normally desirable to monitor the moisture and crude protein content of all feeds, and also the oil and fibre content of poultry feeds and feeds for immature pigs, calves and lambs. The sodium chloride content of poultry feeds (particularly those for layers) should also be determined as a matter of routine, as this should not exceed 2% for adult birds and 1% for chicks.

Checks on the efficiency of the manufacturing process largely relate to the efficiency of mixing the ingredients, particularly the micro-ingredients. This is normally checked by assaying one of the micro-ingredients added at the blending stage of manufacture. For feeds containing a large number of essential micro-ingredients e.g. those for poultry, variations in micro-ingredient, composition due to poor mixing of ±10% from that specified are normally acceptable. Other feeds such as those for ruminants may have variations in micro-ingredients composition of as much as ±25% of that specified and still be considered acceptable. Possible deficiencies in micro-ingredient content due to inadequate mixing are usually allowed for by including 'overages' at the blending stage. Checks on mixing efficiency should be carried out at regular intervals. Analysis of the samples is best carried out in a central laboratory rather than the small mill laboratory.

When pellets or crumbs are produced some physical testing is desirable to ensure that they are of the correct degree of hardness i.e. they should not be so hard as to cause feeding difficulties, and they should not be so soft as to lose their structure during handling. Laboratory instruments have been designed to test the resistance of pellets to abrasion (Sebestyen, 1973), most are based on the principle of a tumbling box. After tumbling for a set period a sieving operation determines the proportion of material still in pellet form. In most cases, however, pellet quality in this respect can be estimated by tests based on practical experience.

Chapter 6

The quality control laboratory

BASIC LABORATORY REQUIREMENTS

As indicated previously, all but the smallest feed compounding enterprises should at least maintain facilities for determining the proximate composition (moisture, crude protein, crude fibre, oil, mineral matter and nitrogen-free extract) of raw materials and finished products, preferably at individual mills. In addition the capacity to carry out additional analyses of, for example sodium chloride, calcium, phosphorus, acid insoluble ash, free fatty acid content and aflatoxin is often highly desirable or even essential.

These analyses do not require very sophisticated equipment and it should be within the capacity of a small laboratory with the normal range of facilities to undertake them. Essential equipment would include normal laboratory glassware, an analytical balance, heating mantles or a boiling water bath for oil extraction, a constant-temperature ventilated oven, a digestion rack and distillation unit for Kjeldahl determination of crude protein, and a muffle furnace.

Further major items of equipment for the additional analyses described in Appendix 2 would include a spectrophotometer, ultra-violet emission lamp, thin layer chromatography equipment, a shaker, and a flame photometer or preferably an atomic absorption spectrophotometer.

Ideally the laboratory examination of samples should be carried out by properly trained staff under the supervision of a qualified analytical chemist. However it is realised that only the larger feed enterprises are able to employ qualified chemists and it is usually necessary for the production management to supervise the day to day operations of the laboratory. Employees with a good secondary school education and appropriate training would be suitable for carrying out the analyses mentioned above under proper supervision, and most mill laboratories would probably be staffed by two such persons. If the mill is one of several operated by the enterprise, technical supervision can be exercised by a single qualified chemist located at either a central laboratory or at one of the mills. If no qualified chemist is employed it will be necessary to arrange training and supervision with an outside organisation e.g. a government analytical laboratory, a consultant or a university department.

Space requirements for a mill laboratory set up and staffed as above would be quite low; an area of about 25 square metres would be sufficient. Furnishings should include fitted laboratory benches for accommodating equipment and providing working areas (about 16 metres of working length will be sufficient), one or, preferably, two fume cupboards and a writing desk. Water and electrical services would be necessary and, in warm climates, air conditioning would be desirable.

The costs of establishing and maintaining such a laboratory will, of course, vary considerably from country to country. However, Appendix 3 provides a guideline to expected costs of furnishings and equipping a small analytical laboratory.

THE ROLE OF THE CENTRAL LABORATORY

Large enterprises will probably be able to maintain a larger central laboratory as well as the small mill laboratories. The role of the central laboratory will be mainly to provide technical supervision for mill laboratories and to co-ordinate their activities as far as necessary. The central laboratory will train the staff recruited for work in mill laboratories, and also provide the mill laboratories with relief staff when necessary. The central laboratory will also carry out the more complicated analysis of raw material mentioned in Chapter 2, and probably also the mixing tests referred to in Chapter 4 & 5. It will also have a particular useful role to play in evaluating unfamiliar raw materials, or materials from new sources of supply, when the fullest information is required before purchasing decisions are made.

The size of the central laboratory and the range of analysis carried out will therefore depend on the size of the enterprise; however, a guideline as to requirements is given in Appendix 3. The value of the central laboratory to the larger organisation both in product quality control and the provision of information to purchasing departments on raw material quality is very great, and such laboratories should be established by the larger enterprises whenever possible.

Chapter 7

The use of quality control data

While quality control procedures are mainly designed to provide information for the day to day operations of feed mills, it is very important that records of information obtained both by the analysis and visual inspection of raw materials and products be carefully maintained. Such records are of immense value in assessing trends in production efficiency and raw material quality.

Quality control data allows a check to be made on the value of purchased raw materials and whether they meet contract specifications, if these have been laid down, of nutrient levels, e.g. crude protein level, or levels of undesirable factors, e.g. toxins. Such data will also be valuable in feed formulation. If a feedstuff contains significant levels of a toxic constituent, it may be necessary to exclude that feedstuff from particular formulations eg feeds for poultry or young stock, or to limit the amount which can be included to a safe upper level.

Data on nutrient levels in raw materials could be of considerable value in the 'least cost' formulation of feeds. Normally analytical data used in formulation programmes is based on average nutrient values for particular feed ingredients and not on actual values found in consignments going through the mill. If the actual data were used, and formulations were varied in line with the nutritional values of the components, considerable savings could be envisaged. However there are two drawbacks to this approach; firstly, rapid laboratory analysis of raw material samples would be needed, and, secondly, computer facilities would be required to carry out the frequent reformulations necessary. But even if the above approach were restricted to one or two major components, eg moisture and protein, it could be worthwhile.

Records of raw material quality are of particular value to the purchasing department and should include a card index classified by commodities and subdivided into individual suppliers. The cards should contain information on date purchased, price, composition as determined by analyses, and comments on other factors eg visual appearance, insect infestation, evidence of moulding etc. which may affect quality. Purchasing departments will thus be able to assess the relative merits and reliability of different raw material suppliers. Changes in the quality of raw materials from suppliers will also be rapidly recognised so that suitable representations can be quickly made to them. This latter aspect is of particular importance in many developing countries where choice of raw material suppliers is very limited, and it may not be possible to change the source of supply of essential raw materials even though quality is unsatisfactory. In such cases it may prove necessary to provide some limited technical assistance to improve raw material quality.

Records of product composition obtained by monitoring macro-constituents such as moisture and protein enable the production manager to keep a continuous check on trends in product quality. The best way of treating figures for product composition is to plot them on 'Cumulative Sum Charts' showing differences between the figure obtained and the specified value for the particular product.

For example if the product is supposed to have a crude protein content of 16% and is found to have one of 16.5% a figure of +0.5 would be plotted on the chart. If the figure obtained were 15.5 per cent −0.5 would be plotted.

Cumulative sum charts for all the product of mills should be plotted continuously and kept on permanent display in the production manager's office. The possible causes of any adverse trend noted from the charts should be investigated promptly.

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Appendix 1

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Appendix 2

Methods of analysis for feeds

Sample preparation

All samples of raw materials and finished products should be stored for analysis in sealed containers. Prior to analysis, samples should be ground to pass through a 1 mm screen; where grinding is difficult a mortar and pestle can be used. In the case of moist samples or where grinding is unduly prolonged moisture determinations should be carried out on the material before and after grinding, as described below.

Moisture determination

Weigh out 4 to 5 g of the sample in a covered, flat, aluminium dish and dry to constant weight at 100°C. preferably in an oven fitted with controlled ventilation.

$$\text{Moisture content (\%)} = \frac{\text{Weight fresh sample} - \text{Weight dry sample}}{\text{Weight fresh sample}} \times 100$$

Crude protein

Total nitrogen is determined by the Kjeldahl method and the result multiplied by 6.25 to give crude protein.

Reagents:

1. Sulphuric acid (98%), nitrogen free.
2. Potassium sulphate, reagent grade..
3. Mercuric oxide, reagent grade.
4. Paraffin wax.
5. Sodium hydroxide, 40% solution.
6. Sodium sulphide, 4% solution.
7. Pumice chips.
8. Boric acid/indicator solution. Add 5 ml of indicator solution (0.1% methyl red and 0.2% bromocresol green in alcohol) to 1 litre saturated boric acid solution.
9. Hydrochloric acid standard solution (0.1N)

Apparatus:

1. Macro Kjeldahl digestion and distillation units.
2. Kjeldahl flasks (500 ml capacity or larger)
3. Conical flasks, 250 ml.

Method:

Weigh accurately approximately 1g of sample into a digestion flask and add 10g potassium sulphate, 0.7g mercuric oxide (pre measured catalyst tablets containing these two reagents are available), and 20ml sulphuric acid. Heat the flask gently at an inclined angle until frothing subsides and then boil until the solution clears.

Continue boiling for a further half hour. If the frothing is excessive, a small amount of paraffin wax can be added.

On cooling add about 90ml distilled water, recool, add 25 ml sulphide solution and mix. Add a small piece of pumice to prevent 'bumping' and 80ml of sodium hydroxide solution while tilting the flask so that two layers are formed. Connect rapidly to the condenser unit, heat and collect distilled ammonia in 50ml boric acid/indicator solution. Collect 50ml of distillate. On completion of distillation remove the receiver (wash condenser tip) and titrate against standard acid solution.

Calculation

Nitrogen content of sample (%)

$$= \frac{\text{(ml acid} \times \text{Normality of standard acid}}{\text{wt of sample (g)}} \times 0.014 \times \frac{100}{1}$$

Crude protein content (%)

$$= \text{nitrogen content} \times 6.25$$

Reference: L. E. Harris (1970) Nutrition research techniques for domestic and wild animals, Volume 1, 2501, L. Harris, Utah State University, Logan, Utah, USA.

Crude fat

Reagents and equipment:

1. Petroleum ether (b.p. 40–60°C).
2. Extraction thimbles.
3. Soxhlet extraction apparatus.

Method:

Weigh into an extraction thimble 2–3g of the dried sample (residue from dry matter determination can be used). Place the thimble inside the soxhlet apparatus place a dry, tared solvent flask in position beneath, add the required quantity of solvent and connect to condenser. Adjust heating rate to give a condensation rate of 2 to 3 drops/second and extract for 16 hours. (The extraction time may be reduced to a minimum of six hours by increasing the condensation rate). On completion remove the thimble and reclaim ether using the apparatus. Complete the removal of ether on a boiling water bath and dry flask at 105°C for 30 minutes. Cool in a desiccator and weigh.

Calculation

Crude fat (% of DM)

$$= \frac{\text{weight of fat}}{\text{weight of sample}} \times \frac{100}{1}$$

Reference: Min. Ag. Fish. Food (1973). The Ferlitizers and Feeding Stuffs Regulations 1973. Statutory Instrument 1973 No. 1521. HMSO, London.

Ash

Weigh a 2g sample into a dry, tared porcelain dish and then place in a muffle furnace at 600°C for 6 hours. Cool in a desiccator and weigh.

Calculation

Ash (%)

$$= \frac{\text{weight of ash}}{\text{weight of sample}} \times \frac{100}{1}$$

Acid soluble and insoluble ash

Reagents and Apparatus:

1. Hydrochloric acid (1 to 2.5 v/v)
2. Filter paper, ashless
3. Dishes, porcelain.

Method:

Use the residue obtained from ash determination. Boil with 25ml hydrochloric acid, taking care to avoid spattering, filter through ashless filter paper and wash with hot water until acid free. Place filter paper and residue into a dry, tared procelain dish and place in a muffle furnace at 600°C for 2 hours or until carbon free.

Calculation

Acid insoluble ash (%)

$$= \frac{\text{weight of acid-treated ash}}{\text{weight of sample}} \times \frac{100}{1}$$

Crude fibre

Crude fibre is determined as that fraction remaining after digestion with standard solutions of sulphuric acid and sodium hydroxide under carefully controlled conditions.

Reagents:

1. Sulphuric acid solution (0.255N).
2. Sodium hydroxide solution (0.313N).
3. Antifoam reagent (Octyl alcohol).
4. Ethyl alcohol.
5. Hydrochloric acid, 1% v/v.

Apparatus:

1. Beakers, 600ml tall-sided
2. Round-bottom flask condenser unit.
3. Buchner flasks, 1 litre.
4. Buchner funnels, Hartley 3 section pattern.
5. Crucibles, silica with porous base.
6. Rubber cones to fit above.

Method:

Weigh about 2g of the dried, fat-free sample into a 600ml beaker (for convenience the residue from ether extraction can be used). Add 200ml of hot sulphuric acid, place the beaker under the condenser and bring to boiling within 1 minute. Boil gently for exactly 30 minutes, using distilled water to maintain volume and to wash down particles adhering to the sides. Use antifoam if necessary. Filter through Whatman No. 541 paper in a Buchner funnel using suction and wash well with boiling water. Transfer residue back to beaker and add 200ml hot sodium hydroxide solution. Replace under the condenser and again bring to boil within 1 minute. After boiling for exactly 30 minutes filter through porous crucible and wash with boiling water, 1% hydrochloric acid and then again with boiling water. Wash twice with alcohol, dry overnight at 100°C, cool and weigh. Ash at 500°C for 3 hours, cool and weigh. Calculate the weight of fibre by difference.

Calculation

Crude fibre (% of fat-free DM)

$$= \frac{\text{(weight crucible + dried residue)} - \text{(weight crucible + ashed residue)}}{\text{(weight of sample)}} \times 100$$

Reference: Official methods of analysis of the AOAC, 1970, 129
Association of Official Analytical Chemists, PO Box 540, Washington D.C. 20044, USA.

Nitrogen-free extract

Calculate as 100–% crude protein – % crude fat –% crude fibre – % ash (all on a dry matter basis).

Free fatty acid content of fats & oils

Reagents and apparatus:

1. Ethyl alcohol.
2. Phenolphthalein (1% soln. in alcohol).
3. Sodium hydroxide (0.25N).
4. Stoppered flasks, 250ml.

Method:

Weigh 7.05g oil or fat into a stoppered flask, add 50ml alcohol previously neutralised by adding sufficient 0.25N sodium hydroxide to give faint pinkish colour with phenolphthalein (2ml). Titrate with sodium hydroxide with vigorous shaking until a permanent faint pink colour appears and persists.

Calculation

Free fatty acids % (as oleic acid)
= volume of 0.25N NaOH used in titration

Reference: Official methods of Analysis of the AOAC, 1970, 446

Calcium

Reagents:

1. Hydrochloric acid (1 to 3 v/v).
2. Nitric acid (70%).
3. Ammonium hydroxide (1 to 1 v/v).
4. Methyl red indicator (Dissolve 1g in 200ml alcohol).
5. Ammonium oxalate (4.2% soln.).
6. Sulphuric acid (98%).
7. Standard potassium permanganate soln. (0.05N).

Apparatus:

1. Porcelain dishes.
2. Volumetric flasks, 250ml.
3. Beakers, 250ml.
4. Quantitative filter paper & funnels.
5. Burette.

Method:

Weigh 2.5g finely ground material into a porcelain dish and ash as above (alternatively use residue from ash determination). Add 40ml hydrochloric acid and a few drops of nitric acid to the residue, boil, cool and transfer to a 250ml volumetric flask. Dilute to volume and mix.

Pipette a suitable aliquot of the solution (100ml for cereal feeds, 25ml for mineral feeds) into a beaker, dilute to 100ml and add 2 drops of methyl red. Add ammonium hydroxide dropwise until a brownish orange colour is obtained, then add two drops of hydrochloric acid to give a pink colour. Dilute with 50ml water, boil and add while stirring 10ml of hot 4.2% ammonium oxalate solution. Adjust pH with acid to bring back pink colour if necessary. Allow precipitate to settle out, and filter, washing precipitate with ammonium hydroxide solution (1 to 50 v/v). Place the filter paper with precipitate back in beaker and add a mixture of 125ml water and 5ml sulphuric acid. Heat to 70°C and titrate against the standard permanganate solution.

Calculation

Calcium (%)

$$= \frac{\text{ml permanganate soln}}{\text{wt sample}} \times \frac{\text{aliquot used (ml)}}{250} \times 0.1$$

Reference: Official methods of Analysis of the AOAC, 1970, 132

Sodium chloride

Reagents

1. Standard 0.1N silver nitrate solution.
2. Standard 0.1N ammonium thiocyanate solution.
3. Ferric indicator – saturated aqueous solution of ferric alum.
4. Potassium permanganate solution – 6% w/v.
5. Urea solution – 5% w/v.
6. Acetone (A.R. grade).

Method:

Weight 2g sample into a 250ml conical flask. Moisten sample with 20ml water and then add, by pipette, 15ml 0.1N silver nitrate solution – mix well. Add 20ml concentrated nitric acid and 10ml potassium permanganate solution and mix. Heat mixture continuously until liquid clears and nitrous fumes are evolved – cool. Add 10ml urea solution and allow to stand for 10 minutes. Add 10ml acetone and 5ml ferric indicator and back titrate the excess silver nitrate with the 0.1N thiocyanate solution to the red brown end point.

Calculation

Calculate result as sodium chloride.

$$\% \text{ NaCl} = \frac{(15.00 - \text{ml } 0.1\text{N } NH_4CNS, \times 0.585}{\text{g sample taken.}}$$

Phosphorous

Reagents:

1. Molybdovanadate reagent. Dissolve 40g ammonium molybdate $4H_2O$ in 400ml hot water and cool. Dissolve 2g ammonium metavanadate in 250ml hot water, cool and add 450ml 70% perchloric acid. Gradually add the molybdate soln to the vanadate solution with stirring and dilute to 2 litres.
2. Phosphorous standards. Prepare stock solution by dissolving 8.788g potassium dihydrogen orthophosphate in water and making up to 1 litre. Prepare the working solution by diluting the stock 1 in 20 (working conc. 0.1mg P/ml).

Apparatus:

1. Spectrophotometer to read at 400 mμ.
2. Graduated flasks, 100ml.

Method:

Pipette an aliquot of the sample solution prepared as for the calcium determination into a 100ml flask and add 20ml of the molybdovanadate reagent. Make up to volume, mix and stand for 10 minutes. Transfer aliquots of the working standard containing 0.5, 0.8, 1.0 and 1.5mg phosphorus to 100ml flasks and treat as above. Read sample at 400 mμ setting the 0.5mg standard at 100% transmission. Determine mg. phosphorus in each sample aliquot from a standard curve.

Reference: Official methods of Analysis of the AOAC, 1970, 12.

Carotene

Reagents:

1. Acetone
2. Hexane (b.p. 60–70°C).
3. Diatomaceous earth.
4. Activated magnesia.

Apparatus:

1. Reflux apparatus.
2. Chromatographic tubes (30cm × 12mm i.d.).
3. Spectrophotometer.

Method:

Weigh out 2 g of sample (more or less depending on carotene content) and reflux with 15 ml of acetone-hexane mixture (3 to 7) for one hour. Cool and filter into a 50 ml volumetric flask, washing with hexane and making up to volume.

Prepare a column using a 1 to 1 mixture of activated magnesia and diatomaceous earth. Pack under vacuum to a total depth of about 7 cm and then add 0.5 cm anhydrous sodium sulphate to the top of the column. All materials used in making the column must be thoroughly dry.

With the column under vacuum and a 50 ml volumetric flask to collect the eluate apply 25 ml of the sample extract to the column. As the last of the extract enters the adsorbent add acetone-hexane eluent (1 to 9) and continue until the carotene band is washed through, add acetone hexane eluent (1 to 9) to the flask to make up to volume and then read in the spectrophotometer at 436 mμ. Prepare a standard curve using beta carotene concentrations of 0.1 to 5 μg/ml of acetone hexane mixture.

Reference: Official methods of Analysis of the AOAC, 1970, 770.

Total sugars in molasses

Reagents:

1. Fehling's solution (Soxhlet modification). (a) Dissolve 34.639 g of copper sulphate 5 H_2O in water and make up to 500 ml. Filter. (b) Dissolve 173 g of Potassium sodium tartrate 4 H_2O and 50 g sodium hydroxide in water, dilute to 500 ml, stand for two days and filter through prepared asbestos.
2. Invert sugar standards. Prepare stock solution by adding 5 ml of hydrochloric acid (sp.g. 1.18) to 9.5 g of sucrose in solution and dilute to around 100 ml. After storing for two days at room temperature dilute to 1 litre. Prepare working solutions (5 mg/ml) by pipetting 100 ml of the stock solution into a 200 ml volumetric flask, and neutralising with 20% sodium hydroxide using phenolphthalein as indicator. Dilute to mark, and mix.

3. Hydrochloric acid (Sp. g. 1.18).
4. Hydrochloric acid (0.5 N).
5. Sodium hydroxide (20%).
6. Phenolphthalein indicator (1% soln. in alcohol).
7. Methylene blue indicator (1% aqueous soln.).

Apparatus:

1. Electric heater.
2. Conical flasks, 300 ml.

Method:

Sample Preparation. For dried molasses, take an 8 g sample and shake with water (250 ml preheated to 60°C) in a 500 ml volumetric flask for 30 minutes. Allow to cool then dilute to volume. Filter, discarding first 25 ml of filtrate. For liquids, dissolve 8 g and make up to 500 ml. Carry out an acid hydrolysis on 100 ml of the filtrate by adding 5 ml of hydrochloric acid (Sp. gr. 1.18) and allowing to stand for 24 hours. Neutralise with sodium hydroxide (20%) using phenolphthalein as indicator and then dilute to 200 ml.

Standardisation of Soxhlet solution. Pipette 10 ml of Soxhlet solutions (a) and (b) into a conical flask, mix and add 30 ml of water. Add from a burette a volume of working standard that is almost sufficient to reduce the copper in the Soxhlet solution. Bring to boiling and continue boiling for two minutes. Add four drops of methylene blue and rapidly complete the titration, while still boiling, until a bright orange colour is resumed. Repeat several times and determine the volume of solution required to completely reduce 20 ml of the Soxhlet solution.

Titration of sample. First, carry out an approximate titration: Pipette 10 ml of solutions (a) and (b) into a flask and add a 10 ml aliquot of the sample solution. Add 40 ml of water and bring to boil. If blue colour persists titrate with working standard solution and calculate the approximate sugar content of the sample.

To determine accurately the sugar content, pipette 10 ml of soxhlet solutions (a) and (b) into a flask and add an aliquot of the sample solution. The volume of sample used will depend on the sugar content of the sample (see table).

Table 1. Sample volumes used in Soxhlet titration

ml H_2O	ml sample	g sample in aliquot	Total sugar as invert, %
40	10	0.08	73
35	15	0.12	82 – 58
30	20	0.16	61 – 41
25	25	0.20	49 – 35
20	30	0.24	41 – 29

(Reproduced from official Methods of Analysis of the AOAC 1970)

Add water as indicated in the table, mix and boil. During boiling add a quantity of working standard from a burette so that the titration is nearly complete. Add methylene blue and complete the titration. Calculate % sugar (as invert) by the formula.

% sugar = $(F - M) \times I \times 100/W$, where F is the volume of standard needed to reduce 20 ml of Soxhlet solution, M is the volume of standard sugar solution required to complete the back titration, I is the weight of invert sugar in 1 ml of working standard and W is weight of sample in aliquot used.

Reference: Official methods of Analysis of the AOAC, 1970, 540.

Potassium in molasses

Reagents and equipment:

1. Hydrochloric acid (concentrated)
2. Potassium standard. To prepare stock solution (500 ppm K) dissolve 0.477 g potassium chloride (Analar) and make up to 500 ml with distilled water. To prepare working standard (10 ppm) dilute 1:50.
3. Silica crucibles.
4. Flame photometer.
5. Muffle furnace.

Method:

Dry 2 g of sample in a silica crucible at 100°C to expel moisture. Add a few drops pure olive oil and heat over flame until swelling stops. Ash at 500°C in muffle furnace for 24 hours, cool and add 2 ml concentrated hydrochloric acid to dissolve the residue. Make up to 100 ml. Take one ml of this solution and make a further dilution to 100 ml.

Set the flame photometer to give a reading of 100 with the 10 ppm standard and then read sample solution. If the sample reading does not fall between 50 and 100 make a fresh dilution to give an appropriate reading.

Urease activity in soybean meal

Reagents:

1. Dimethylaminobenzaldehyde soln. (DMAB). Dissolve 16 g DMAB in 1 litre 95% ethyl alcohol and add 100 ml concentrated hydrochloric acid (Stable 1 month).
2. Pyrophosphate buffer. Dissolve 23.3 g $Na_4 P_2 O_7 10H_2O$ in approximately 980 ml distilled water. Add 3 ml of conc. HCl and then dropwise further HCl until the pH of the buffer is 7.7 to 7.8. Dilute to 1 litre.
3. Buffered urea solution. Dissolve 0.4 g urea in 1 litre pyrophosphate buffer (Stable 1 week).
4. Zinc Acetate soln. Dissolve 22.0 g zinc acetate $2H_2O$ in distilled water, add 3 ml of glacial acetate acid and dilute to 100 ml.
5. Potassium Ferrocyanide soln. Dissolve 10.6 g $K_4Fe(CN)_6 3H_2O$ in distilled water, and dilute to 100 ml.
6. Charcoal.

Apparatus:

Water bath at 40°C, capable of maintaining temperature within ∓ 1°C, with shaking device.
Conical flasks, 125 ml.
Volumetric flasks, 25 ml.
Spectrophotometer.

Method:

Weigh accurately 1 g of soybean meal into a conical flask and add 50 ml of the buffered urea solution. Incubate in water bath for 30 minutes exactly at 40°C with shaking. Remove from water bath and quickly add 0.5 ml each of conc HCl, ferrocyanide soln. and zinc acetate soln. and 0.1 g of charcoal. Shake for 15 minutes and filter. If the filtrate is coloured, repeat the procedure using more charcoal. Pipette 10 ml aliquots of the filtrate and the DMAB solution into a 25 ml volumetric flask and make up to volume with distilled water. Make up also a reagent blank (10 ml DMAB made up to 25 ml with water) and a urea blank (10 ml buffered urea solution and 10 ml DMAB made up to 25 ml with water). Prepare a standard curve by pipetting aliquots of buffered urea solution from 2 to 12 mls into 25 ml volumetric flasks, adding 10 ml of DMAB and making up to volume.

Mix flasks well, stand in water bath at 25°C for 10 mins and then read at 430 mμ. Calculate urease activity as mg/litre urea in urea blank – mg/litre urea in sample.

Reference: G. Schram and P. D. Aines (1959). Colorimetric determination of urease activity in soybean meals *J. Am. Oil Chem. Soc.* **36**, 1–3.

Free gossypol in cottonseed meal

Two procedures are described for the determination of free gossypol, the first for normal meals and the second for meals which have been chemically treated and so contain dianilinogossypol.

Reagents:

1. Aqueous acetone. 7 parts acetone, 3 parts distilled water (v/v).
2. Aqueous acetone – aniline solution. To 700 ml acetone and 300 ml distilled water add 0.5 ml redistilled aniline. Prepare solution daily.
3. Aqueous isopropyl alcohol solution. 8 parts isopropyl alcohol, 2 parts distilled water (v/v).
4. Aniline. Distill reagent grade aniline over a small quantity of zinc dust, discarding the first and last 10% of the distillate. Store refrigerated in a brown glass stoppered bottle. Stable several months.
5. Standard gossypol solution. (a) Dissolve 25 mg of pure gossypol in aniline-free acetone and transfer to a 250 ml volumetric flask using 100 ml of acetone. Add 75 ml of distilled water, dilute to volume with acetone and mix. (b) Take 50 ml of solution (a), add 100 ml pure acetone, 60 ml of distilled water, mix and dilute to 250 ml with pure acetone. Solution (b) contains 0.02 mg gossypol/ml and is stable for 24 hours in darkness.

Apparatus:

1. Mechanical shaker.
2. Spectrophotometer.
3. Conical flasks, 250 ml capacity.
4. Volumetric flasks, 25 & 250 ml.
5. Water bath (boiling).

Method:

Grind sample to pass 1 mm screen taking care not to overheat. Take approximately 1 g of the sample and add 25 ml of pure acetone. Stir for a few minutes, filter, and divide filtrate into two. To one portion add a pellet of sodium hydroxide and heat in a water bath for a few minutes. A deep orange red colour in the tube containing sodium hydroxide indicates the presence of dianilinogossypol and procedure (2) should be used. A light yellow extract which does not change colour with sodium hydroxide indicates that the cottonseed meal is untreated and procedure (1) should be used.

Procedure (1): Weigh out 0.5 to 1 g of sample, depending on expected gossypol content, into a conical flask and add glass beads. Pipette in 50 ml of aqueous acetone solution, stopper the flask and shake for one hour. Filter, discarding the first few mls of filtrate and then pipette out duplicate aliquots into 25 ml volumetric flasks. (Take aliquots from 2 to 10 ml, again depending on expected gossypol content). Dilute one of the aliquots to volume with aqueous isopropyl alcohol (Soln. A.), while to the other aliquot (Soln. B.) add 2 ml redistilled aniline and heat in a boiling water bath for 30 minutes together with a reagent blank containing 2 ml of aniline and a volume of aqueous acetone solution equal to the sample aliquot. Remove soln. B and the blank, add sufficient aqueous isopropyl alcohol to effect homogenous solution and cool to room temperature in a water bath. Dilute to volume with aqueous isopropyl alcohol.

Read samples at 400 mμ. Set instrument to 0 absorbance with aqueous isopropyl alcohol, and determine absorbance of solution A and reagent blank. If the reagent blank is below 0.022 absorbance proceed as below, otherwise repeat the analysis using freshly distilled aniline.

Determine the absorbance of solution B, with the reagent blank set at 0 absorbance. Calculate the corrected absorbance of the sample aliquot: Corrected absorbance: (Absorbance soln. B – Absorbance Soln. A.). Determine the mg free gossypol present in the sample solution using the calibration curve (see below).

Procedure (2): Weigh out 1 g of sample into a conical flask, add 50 ml aqueous acetone and shake and filter as above. Pipette duplicate aliquots of the filtrate (from 2 to 5 ml depending on expected free gossypol level) into 25 ml volumetric flasks. Dilute one of the aliquots to volume (soln. A.) with aqueous isopropyl alcohol and leave for at least 30 mins before reading on the spectrophotometer. Treat the other aliquot (soln. B.) as in procedure (1), determine absorbances of solutions (A) and (B) as before and calculate the apparent content of gossypol in both solutions A and B using the calibration curve (see below).

Preparation of calibration curve: Pipette duplicate 1,2,3,4,5,7,8 and 10 ml aliquots of the 0.02 mg/ml gossypol standard into 25 ml volumetric flasks. Dilute one set (solution A) to volume with aqueous isopropyl alcohol and determine absorbances as previously. To the other set (solution B) add 2 ml of redistilled aniline and proceed as previously. Prepare one reagent blank, using 2 ml aniline and 10 ml of aqueous acetone, heated together with the standards. Determine absorbances as in Procedure (1) and calculate the corrected optical density for each standard solution:

Corrected absorbance = (absorbance soln. B – absorbance soln. A) Plot the standard curve, plotting corrected absorbance against gossypol conc. in the 25 ml volume.

Calculate free gossypol % in normal meals as: Free gossypol % = $\frac{5G}{WV}$

where G is the graph reading, W = sample weight and V = aliquot volume used.
For chemically treated meals: Free gossypol % = $\frac{5\,(B - A)}{WV}$

where A = mg apparent free gossypol in sample aliquot (A)
B = mg apparent free gossypol in sample aliquot (B)
W = sample weight V = aliquot volume used.

Reference: American Oil Chemists Society (1972) Official and tentative methods, 3rd Edition, Method Ba 7–58

Thioglucoside determination

The method described will give approximate thioglucoside content but does not allow the individual thioglucosides and isothiocyanates to be determined.

Reagents and apparatus:

1. Barium chloride (5% solution).
2. Volumetric flasks, 600 ml.
3. Steam bath.

Method:

To 10 g meal (de-fatted by Soxhlet extraction) add 250 ml distilled water, hydrolyse at 54°C for 1 hour and then boil for two hours, keeping volume constant. Filter, retaining filtrate, and wash residue three times with 50 ml hot water. Add washings to initial filtrate and make up volume to 600 ml. Precipitate

barium sulphate by heating and adding excess barium chloride solution. Leave on a steam bath for a few hours and then filter. Ash in a muffle furnace and then weigh precipitate.

Calculate approximate thioglucoisde content as:

$$\% \text{ thioglucoside} = \frac{(\text{M. wt. thioglucoside})\ (\text{Wt. of } BaSO_4)}{(\text{M.wt. } BaSO_4)\ (\text{Sample Wt})} \times 100$$

Reference: J. E. McGhee, L. O. Kirk, and G. C. Mustakas, (1965). Methods of determining thioglucosides in Crambe abyssinica *J. Am. Oil Chem. Soc.* **42** 889–891.

Aflatoxin analysis

A method of aflatoxin analysis is outlined below which is suitable for materials such as groundnut meal, coconut meal and palm kernel meal. For full details of the method and for alternative procedures reference should be made to B. D. Jones (1972) Methods of aflatoxin analysis. Report No G70, Tropical Products Institute London.

Reagents:

1. Chloroform (Reagent grade).
2. Diethyl ether (Reagent grade).
3. Chloroform/methanol mixture (95/5 v/v).
4. 'Celite', diatomaceous earth.
5. Kieselgel 'G' (Merck).
6. Qualitative standard. Helps to distinguish aflatoxin spots from other fluorescent spots which may be present. A groundnut meal containing aflatoxins B, obtainable from the Tropical Products Institute, London, can be used for this purpose.

Apparatus:

1. Thin layer chromatography plates, 20 × 20 cm.
2. U.V. lamp, peak emission at 365 mμ.
3. Bottles, wide-mouthed, 250 ml.
4. Micropipettes.
5. Shaking device.

Method:

Weigh 10 ml of material into a wide mouthed bottle and thoroughly mix in 10 ml of water. (If high fat material is used, a prior Soxhlet extraction with petroleum ether will be necessary). Add 100 ml of chloroform, stopper with a chloroform resistant bung and shake for 30 minutes. Filter the extract through 'Celite', take 20 ml of filtrate and make up to 25 ml (Soln. A.). Take another 20 ml of filtrate and concentrate to 5 ml (Soln. B.).

Prepare thin layer plates by shaking Kieselgel 'G' (100 g) with water (220 ml) for 20 minutes and applying the mixture to the plates with a suitable apparatus to a depth of 508 μ. Leave for 1 hour, then dry at 100°C. Spot 10 and 20 μl of solution B and 5 and 10 μl of solution A onto a plate, together with a qualitative standard spot, in a line 2 cm from the bottom of the plate and at least 2 cm in from each side. Carry out the spot application in subdued light.

Develop the plate in diethyl ether to a height of 12 cm. Allow to dry in subdued light then redevelop the plate in chloroform methanol (95/5, v/v) to a height of 10 cm from the baseline. Examine the plate in a dark room, 30 cm from the UV source. The presence of a blue fluorescent spot at Rf 0.5 to 0.55 indicates aflatoxin B (check that the standard spot also lies in this range). The presence of

a second spot at Rf 0.45 to 5 indicates aflatoxin G. The toxicity level of a sample can then be classified in terms of aflatoxins B & G according to the following table.

Vol. applied (μl)	Conc. of aflatoxins (μg/kg)		Toxicity level of fluorescence observed
	No fluorescence	Fluorescence	
5 μl (Soln. A)	< 1000	> 1000	very high
10 μl (Soln. A)	< 500	500 – 1000	high
10 μl (Soln. B)	< 100	100 – 500	medium
20 μl (Soln. B)	< 50	50 – 100	low

Reference: Jones, (1972).

Appendix 3

Requirements of the quality control laboratory and estimated costs

Requirements for floor space, furnishings and equipment have been estimated for two laboratory models representing the small mill laboratory and the larger central type of laboratory (Table 1). It is assumed that the former would be used for basic analytical procedures only and would be capable of being run by two people whereas the central laboratory would undertake a larger range of procedures and could also be used for training purposes, as discussed in Chapter 6.

COSTS

Capital costs will include the costs of the structure housing the laboratory, and furnishings and equipment. The cost of the structure could vary widely depending on location, materials used in construction, and whether the structure is an integral part of a larger building or is a separate building. Again the costs of furnishing could vary widely. In Table 1 a yardstick to costs of furnishings and equipment is given based on 1974 ex works prices in the United Kingdom.

Annual running costs will include labour costs, costs of services (water and electricity) and replacement costs (breakages, chemicals etc.). Allowance must also be made for maintenance and repairs of the laboratory structure and for its insurance. No estimates can be made of these, as they will vary depending on country and location.

Table 1

Requirements of the Quality Control Laboratory

	Model 1		Model 2	
	Requirement	Cost (£ sterling 1974)	Requirement	Cost (£ sterling 1974)
Floor space (m^2)	25		75	
Bench space (m)	12	1080	37	3330
Power supply: Electrical outlets (Bench)	9		28	
Electrical outlets (Other)	4		4	
approximate electric loading (amps)	60		130	
Water supply, Hot and cold supplies	√		√	
High pressure supply	√		√	
Equipment				
Fume cupboard	2	600	3	900
Analytical balance 0–200 g reading 0.0001 g.	1	390	1	390
Top-pan Balance 0–1000 g reading 0.01 g.	1	150	1	150
Oven 0–200°C	1	250	1	250
Muffle furnace 0–1200°C	1	200	1	200
Steam bath (12 hole)	1	40	1	40
Steam bath (6 hole)			1	30
Kjeldahl units	1	180	2	360
Shaker			1	80
Spectrophotometer	1	250	1	750
U V lamp			1	25
T L C equipment			1	100
Heating mantles (unit of 6)			1	112
Laboratory grinder	1	15	1	15
Atomic absorption spectrophotometer			1	800
Water still	1	50	1	50
Chemicals		150		350
General glassware		200		300
Approximate total cost furnishings and equipment		3600		8300

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Sack filling: methods and equipment

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Tropical Products Institute 56/62 Gray's Inn Road London WC1X 8LU
Ministry of Overseas Development

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Contents

Sack filling : methods and equipment

SUMMARY

The operations involved in filling and closing open-mouth sacks are examined, and the machinery available is discussed. Suppliers of equipment are listed.

INTRODUCTION

Despite the increasing use both of bulk transport and of unit retail packs, packaging of granular and powdered commodities in sacks remains very important in both international and domestic trade. Techniques ranging from entirely manual to fully automatic are used for carrying out the packaging operation, and in this report an attempt is made to list and classify these. Only open-mouth sacks are considered, with capacities in the range of 20—100 kg, and emphasis is placed upon free-flowing commodities.

The situations in which sacks may be required to be filled can be initially classified, according to the disposition of the commodity before packaging, as follows:

Case 1 Bulk commodity with top or side access, for example: heaped on the ground or in a ship's hold.

Case 2 Bulk commodity in silos and hoppers with chute or other discharge arrangement.

Case 3 Commodity flowing in a stream from a processing operation, for example: grading, shelling or milling.

However the differences between these cases usually disappear in practice. In case 1, no packaging machine as such can operate; the commodity may be filled into sacks entirely manually, while if a mechanical handling device such as an auger is used, either as an aid to manual filling or to move the commodity to a packaging machine, the situation is effectively converted to case 3. Similarly, when the discharge system of case 2 is operated, the situation becomes in principle indistinguishable from case 3, and the two cases are further confused because a machine accepting a flow will usually include a buffer hopper. There is therefore no need for the discussion of mechanised systems to be related to the above 3 situations.

The principal groups of operations in filling a sack are listed below.

1 Pick up empty sack and present for filling.

2 Fill contents to correct weight.

3 Remove from filler, form sack mouth and present for closing.

4 Close mouth of sack.

5 Remove to stack or pallet.

Each of these groups of operations will be discussed in respect of the methods available for open mouth sacks of jute, woven plastics, multiwall paper, and plastics film. The appendices give additional information about equipment and suppliers.

OPERATION 1: PICK UP EMPTY SACK AND PRESENT FOR FILLING

This is perhaps the most difficult operation to mechanise. However for paper and plastics film sacks it can be done mechanically, as part of a fully automatic process. The sacks are gripped by suction: this is ineffective with jute and woven plastics, and these can only be handled manually, whether the remainder of the filling process is mechanised or not. For plastics film sacks there is a further possibility which eliminates the need to pick up sacks; machines are available which will make sacks from rolls of tubing and then fill them.

For manual filling the mouth of the sack must be held open, by hand or perhaps by clamping to a suitable holder. In mechanised processes sacks are filled through a spout, normally being clamped to it by jaws which are designed according to the sack material. Clamps may be purely mechanical or be pneumatically powered; pneumatic jaws may be actuated by hand or foot switch, or may be arranged to close automatically on insertion of a sack.

OPERATION 2: FILLING CONTENTS TO CORRECT WEIGHT

Manual procedures will vary according to the situations described in the Introduction, but in each instance the sack will usually be filled until the quantity is judged by volume to be close to the correct value. In the most primitive processes the sack may be used as a measure, but this is most undesirable for traded produce as small errors in sack dimensions can produce relatively large variations in capacity. Generally therefore the weight will be adjusted after most of the commodity has been put into the sack.

With the bulk commodity in flat storage, a shovel or bucket is the usual implement for filling; the design of the shovel may appreciably affect the efficiency of the operation. Commodity in a hopper may be discharged through a hand-operated slide valve into the sack held on a spout. Processing machinery will normally have an outlet to which sacks can be presented by hand.

For weight adjustment, the near-filled sack is transferred to a weighing machine, and commodity added or removed using a hand-shovel or scoop, until the weight is correct. The usual type of weighing machine is a platform scale, either of the simple steelyard or predetermined weight (semi-indicating) type; a suspended steelyard or dial spring balance with suitable suspension arrangements might also be used.

Weighing machines used in more mechanised processes fall into two classes, gross weighers and net weighers. Most weigh by mechanical means, although some electronic weighers are now available. In gross weighers, the sack is used as the weighing container. These machines may be further divided into the following 3 types:

A Sack held at top only

B Sack held at top, and bottom resting on platform

C Sack top free, bottom resting on weighing platform

Type A machines are those commonly used for granular and other commodities; they are usually of moderate output and accuracy, and are available in semi- and

fully-automatic versions. Many Type B machines are designed especially for handling root crops and vegetables. Type C machines are designed particularly for accurate weighing of dusty powders, and include such refinements as auger feeders and sack lowering mechanisms, to allow filling of the sack from the bottom.

In semi-automatic gross weighers the product flow into the sack continues until the weight is close to the required value, and then stops. The operator controls further additions of product until the weight indication is correct. Automatic versions enable the fine weight adjustment to be carried out without supervision.

Net weighers include a hopper into which the commodity is weighed. The actual weighing is normally automatic, while discharge from the hopper may be automatic when a sack is placed in position, or manually controlled. Net weighers are capable of greater accuracy and outputs than general purpose gross weighers, with suitable commodities. Gross weighers are however preferable with sticky materials which could build up on weighing hoppers.

When fillings meals, flours and other materials which can be compacted, vertical vibration of the sack at a suitable frequency ('possing') can give a substantial increase in density with consequent saving in sack dimensions. Possing machinery carries the sackholder, which is flexibly connected to the weigher discharge, and is thus in effect an accessory to the weighing machine.

Any weighing machine requires a reasonably uniform flow of commodity to give good results. Where gravity feed from a hopper is unsatisfactory, screw, belt, or vibratory feeders have to be used. These substantially increase the cost of the assembly, and require power, although the weighers themselves often do not. Choice of weighing machines may in some cases be restricted by the requirements of weights and measures authorities.

OPERATION 3: FROM FILLING TO CLOSING

The group includes removing the sack from the filler, moving it to the point of closing, and forming the mouth for closing. A sack which has been weighed on a platform scale is likely to be simply manhandled a short distance for closing, although it is possible that in some circumstances the filled sack might be taken away on a conveyor. Sacks which are suspended from a spout for filling by a gross or net weigher are removed simply by releasing the clamp (manually or automatically) and normally drop directly onto a conveyor. The latter may comprise a bogie running on rails (for small outputs) or a slatted or belt conveyor. In each case the conveyor requires at least one side-rail, to maintain the filled open sack in a vertical position. Platform-type gross weighers require manhandling of the filled sack off the machine, unless a special sack removing mechanism is fitted.

A conveyor between filling and closing may include a weighing machine to allow checking (and, if necessary, correction) of the weight before closing.

Any closing operation requires the mouth of the sack to be properly formed first. For hand sewing and bunch tieing this preparation can only be by hand. Machine sewing of jute and woven plastics always requres the sack mouth to be formed to some extent, and entered into the sewing machine by hand. For paper and heavy duty film sacks, the need for hand-work may be reduced if suitable sacks and equipment are used; infeed devices on closing machines may accept without assistance sacks which have been formed by hand, or even as from the filling spout. Alternatively, machinery is available to shape the mouth and transfer these sacks automatically to the closing machine under full control, usually as part of a fully automatic filling line.

OPERATION 4: CLOSING

There are 4 basic techniques, each with a number of variations.

A **Bunch tieing:** a manual operation, which requires no equipment if string or a natural fibrous material is used. For wire-tieing a simple hand tool is required. This method requires extra length in the sack to provide sufficient material in the bunch; it can be used with any sack material, and is particularly favoured for field use and for temporary closure.

B **Hand sewing.** There are two main styles, with and without 'ears'. The only equipment required is an appropriate needle. The quality of closure is very dependant on the operator, and tends to fall as the pressure of work is increased. It is suitable only for jute or certain woven plastics sacks.

C **Machine sewing.** Machines may be divided into 3 classes:

1 Portable light-duty machines, which may be hand-held, suspended, or on a lightweight stand.

2 Fixed machines with conveyors, stitching under the control of the operator.

3 Fixed machines, as (2) but with automatic starting, stopping, and cut-off.

In each class there is a choice of machines forming single thread chain stitch or two-thread double locked stitch, and the possibility of applying crepe paper tape and filler cord (for paper sacks). Some manufacturers offer different sewing heads for textile and paper sacks, while others have machines which operate on both materials. While all types of sack can be machine-sewn, it is not a usual method for closing plastics film sacks. The highest outputs are achieved applying plain stitching without tape, to paper sacks, in a semi-automatic process.

D **Heat sealing.** Heat sealing proper can only be used for plastics film sacks and for plastics liners in paper or textile sacks. Three types of machine are available.

1 Impulse sealer, operating intermittently under manual control.

2 Continuous flow, band sealer.

3 Continuous flow, hot-air sealer.

The two types of continuous sealer, though working on different principles, are generally similar in operation. Attachments are available for both to clean the sack mouth before sealing, when dusty products are being filled.

For paper sacks with separate plastic film liners, two techniques are commonly used. In the first, the liner is made longer than the sack; it is heatsealed (or tied), then tucked down by hand into the paper sack which is then sewn. In the second technique, which can be completely mechanised, the liner is the same length as the sack. The assembly is first sewn, through paper and film, and the liner is then heat-sealed through the paper below the stitching; at the same time a paper tape may be heat-sealed over the stitching and the mouth of the sack. Related to heat-sealing is the use of a hot-melt adhesive for closing paper sacks. The adhesive is applied to proprietary designs of sack (which may have plastic film liners) at the time of manufacture, and when the sack is required to be closed is activated by heat, and the sealing surfaces brought into contact. The machinery is of the continuous-flow type.

OPERATION 5: REMOVAL TO STACK OR PALLET

After closing, sacks may be removed by manual labour or by conveyor. Conveying systems are normally of the chain-and-slat type, and are designed according to the particular requirements of the plant. A number of special items of equipment may be incorporated in the conveying system. Turning devices may be fitted if the sacks are required in a defined attitude. Flattening machines may be used to shape filled sacks and thereby help to ensure good stacking. Checkweighers may

be employed to provide automatic verification of the filled weight. Palletising of sacks may be performed by machine, operating either semi- or fully automatically; however manual labour is much more commonly used.

CONCLUSION

It is clear that there is a much wider choice of mechanised systems available for filling paper and plastics film sacks than for the textile sacks, jute and woven plastics. There appears to be a lack of cheap simple equipment to facilitate essentially manual operations.

Evaluation of the optimum system for model situations is made difficult for a number of reasons. Reliable information on the performance obtainable in practice in manual operations such as shovelling grain is not available. Machinery costs and performance estimates are markedly affected by the details of production conditions, so that an arbitrary choice of model may give a picture which is not generally applicable. Manufacturers price indications for machinery may be misleading, as ancillary requirements such as structural steelwork, hoppers and conveyors can add very substantially to costs. However in a real situation, with defined objectives and constraints, the choice of an appropriate packaging system should not present unusual difficulties.

Appendix 1 Equipment

Equipment type	Typical speed Sacks/min.	Price indication	Notes	Suppliers (Appendix 2)
Sack presenter	10	£5000	Paper or plastic film. Often part of automatic line.	5 9 20
Sack holder/filling spout	–	Up to £200	Different grip designs for jute and paper, and for gusseted sacks. Manual and pneumatic versions.	12 20 23 26
Sack holding stands	–	£25	May assist manual filling in some cases.	16 28
Slide valve/sackholder	–	£15	For attachment to existing hopper or outlet. Manually operated. Pneumatic slides also available at higher cost.	11 19
Hopper with outlet	–	£250 (1 ton size)	For manual filling of sacks.	4 16 19 25
Weigher, platform		£150 upwards	Dial type more expensive than steelyard.	3 23 24 27
Weigher, spring balance		£10–£40	Require suspension arrangements.	24
Gross weigher, semi-automatic or automatic (type A, suspended sacks)	3–4	£400 upwards	Price may be raised to over £1000 if screw or belt feeder required.	3 4 12 14 23 26 27
Gross weigher, (type B, sack held top and bottom)	3	£300	Feed hopper or elevator extra. Suppliers marked + offer machines designed for root crops.	6+ 8 15+ 17+ 21
Gross weigher with auger fill and sack lowering (type C)	4–7	£4000	Particularly for dusty products of high value.	1 2 29 31
Net weighers, simple mechanical	5	£500	Unpowered, mechanical operation.	4 26
Net weighers, automatic	6–15	£1500	Price increased to over £4000 in most complex versions with feeders.	3 12 23 26 27
Filled sack transfer mechanism (filler to closer, preparing mouth)	12	£2000	Usually part of automatic line. Paper or film sacks.	5 9 20 27 33
Wire tieing tools	3–4	£5–10		10 28
Stitchers, portable	2	£200–£350	Stitching rate up to 15 m/min; output given allows for forming mouth etc.	7 9 14 20 23 28 30
Stitchers, pedestal	–	£600	Head only.	
Stitchers, pedestal with bogie	3	£800–£1000	Output quoted allows for forming mouth etc. with single operator.	7 9 14 20 28
Stitchers, pedestal with belt or slat conveyor	5–24	£1100–£2500	Maximum speed with jute sacks 10/min. Automatic stitchers with paper sacks will close up to 12/min.	
Fully automatic filling/closing line	10	£20 000	Paper sacks only.	9 20

Heat sealers, impulse	1–2	£350		13	33	
Heat sealers, band	15	£3500	Including conveyor.	7	33	
Heat sealers, hot air	10	£1200	Including conveyor.	28		
Combined sealer and stitcher for film lined paper sacks	10	£2000 upwards		7	28	33
Sack closing machine, paper sacks with pre-applied hot melt adhesive	10	£5000	Paper sacks are special design.	7	20	
Sack flatteners	12	. . . .	Normally used only on paper sacks.	20		
Sack palletisers	25	£15 000	Built to specific requirements.	16	31	
Plastic film sack forming and filling machine	15	. . . .		18	22	

Footnotes: * and many other suppliers

Suppliers quoted are UK manufacturers, or UK agents of overseas companies. The list is believed to be reasonably comprehensive except for items marked *, inclusion or omission of a supplier does not represent a recommendation or criticism of the company or its products.

Prices as at October 1974.

1 Arenco-Alite Ltd., Pixmore Avenue, Letchworth, Herts.
2 Autopack Ltd., P O Box 2, Malvern, Hereford & Worcs.
3 W & T Avery Ltd., Smethwick, Warley, W. Midlands.
4 Alvan Blanch Developments Ltd., Chelworth, Malmesbury, Wilts.
5 Christy & Norris Ltd., Broomfield Road, Chelmsford, Essex
6 Cooch & Sons Ltd., Kettering Road North, Northampton
7 Doboy Ltd., Lyon Way, Hatfield Road, St Albans, Herts.
8 Entecon Ltd., London Road, Blackwater, Camberley, Surrey GU17 9AP
9 Glaessners (Bury) Ltd., Glaessner House, Walmersley Road, Bury BL9 5AE
10 Gordian Strapping Ltd., Bromwells Lane, Feltham, Middx.
11 F & R Valves Ltd., Hemyock, Cullompton, Devon EX15 3RQ
12 Howe Richardson Scale Co. Ltd., Bestwood Estate, Nottingham NG5 5HD
13 Jayseal Packaging Engineers, Stirchley House, Reddicap Trading Estate, Sutton Coldfield B75 7BU
14 Thomas C Keay Ltd., P O Box 30, Densfield Works, Dundee DD1 9DY
15 Lockwood Graders (UK) Ltd., Eves Corner, Danbury, Chelmsford, Essex CM3 4NH
16 Lodematic Components Ltd., Primrose, Clitheroe, Lancs.
17 Novotechnics Ltd., Jubilee Road, Letchworth, Herts.
18 Henry Petzold & Co., 51 The Mall, Ealing, London W5 3TA
19 E Rand & Sons (Ipswich) Ltd., Claydon, Ipswich, Suffolk
20 Reed Medway Packaging Systems, Larkfield, Maidstone, Kent
21 Regis Machinery (Sussex) Ltd., Richmond Road, Bognor Regis, Sussex
22 Rockwell Packaging Machines Ltd., Welsh Harp, Edgware Road, London NW2
23 Sack Fillers Ltd., Northfleet, Gravesend, Kent
24 Salter Industrial Measurement Ltd., George Street, West Bromwich, West Midlands B70 6AD
25 Scottish Mechanical Light Industries Ltd., Waggon Road, Ayr KA8 8BB
26 Richard Simon & Sons Ltd., Vernon Road, Basford, Nottingham
27 C Stevens & Son (Weighing Machines) Ltd., 287/289 Goswell Road, London EC1V 7LD
28 Thames Packaging Equipment Co., Senate House, Tyssen St., London E8 2ND
29 Transmatic Fyllan Ltd., Biddenham Works, Old Ford Road, Bedford
30 Malcom Ross & Sons Ltd., P O Box 4, 4 Trafford Road, Alderley Edge, Cheshire SK9 7PR
31 Van den Bergh Walkinshaw Ltd., P O Box 19, 4 Sheet St., Windsor, Berks.
32 Weighpack Ltd., Pigetts Lane, Moonsmoat, Redditch, Hereford & Worcs.
33 Whitehall Machinery Ltd., Chalks Road, Whitehall, Bristol BS 5 9ER

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Summaries

SUMMARY

The market potential for papain

The report contains four chapters. The first outlines the characteristics, functions and utilisation of papain, emphasising its role as an enzyme. The second examines in detail the many technological options available to the principal industrial users and makes an assessment of potential use of papain in this context. The third describes the existing and changing pattern of world trade and is supported by a statistical analysis and appendix. The fourth outlines the difficulties in measurement of enzyme activity and hence in establishing world-wide standards. References and sources of information are given and a further appendix provides addresses in the trade and the names of industrial users.

The current pattern of demand for papain appears to be a continuation of the historical one, namely a slightly rising trend. The principal uses are still beer chillproofing and meat tenderisation. Future prospects on the demand side would seem to indicate a rather more perceptible rising trend than hitherto. The greatest potential for increased use of papain is in enzyme tenderisation of meat and possibly also in fish protein extraction. Little is known as yet about the latter, but the former depends on the increasing popularity of enzyme tenderisation being reflected in permitting legislation in various highly industrialised countries, notably in Western European countries, Australia and New Zealand. This legislative process is a slow one. The greatest dangers to increased use of papain are (1) the insolubilisation of papain for chillproofing and (2) vacuum-packing and other techniques in the meat industry. These dangers are more likely to be effective in the long-term and even then the demand for papain is likely to remain stable amongst existing users.

There is an identifiable trend towards the use of spray-dried papain as against oven-dried crude papain. This trend may be a function firstly of the decreasing quality of crude papains in recent years, and secondly of the availability of high quality spray-dried papain in powder form from Zaire, and therefore a decreasing need to import refined papain preparations from certain highly industrialised countries.

On the supply side, the well-known 'papain cycle' appears to be breaking down in recent years under the impact of the new technology for producing spray-dried papain, international currency difficulties, inflation, mosaic disease in Sri Lanka (Ceylon), and the disruption of the industry in Uganda.

Stabilisation of both supply and demand might be facilitated by the establishment of national marketing boards allied with policies for improving harvesting, storage, packaging and marketing.

RESUME

Les possibilités du marché de la papaïne

Le rapport comporte quatre chapitres. Le premier donne un aperçu des caractéristiques, des fonctions et de l'utilisation de la papaïne, en soulignant son rôle en tant qu'enzyme. Le second examine en détail les nombreux choix technologiques dont disposent les principaux utilisateurs industriels et fait une évaluation de l'utilisation possible de la papaïne dans ce contexte. Le troisième décrit le plan existant et changeant du marché mondial et il est étayé par une analyse statistique et un appendice. Le quatrième indique les difficultés de la détermination de l'activité enzymatique et, par suite, de l'établissement de normes sur le plan mondial. On donne les références et les sources d'information et un autre appendice fournit les adresses dans le négoce et les noms des utilisateurs industriels.

Le plan actuel de la demande en papaïne semble être une continuation du plan historique, à savoir une légère tendance à l'augmentation. Les principales utilisations sont encore la protection de la bière contre la réfrigération et l'attendrissement de la viande. Les perspectives futures de la demande sembleraient indiquer une tendance plus perceptible à l'augmentation. La possibilité la plus importante pour une utilisation accrue de la papaïne réside dans l'attendrissement enzymatique de la viande et peut-être aussi dans l'extraction des protéines de poisson. Jusqu'à présent, on connait peu de chose au sujet de cette dernière, mais la première dépend de la popularité croissante de l'attendrissement enzymatique qui se reflète dans son autorisation légale dans divers pays très industrialisés, notamment dans les pays d'Europe occidentale, en Australie et en Nouvelle-Zélande. Ce processus légal est lent. Les plus grands dangers de l'utilisation plus étendue de la papaïne sont: (1) l'insolubilisation de la papaïne pour la protection contre la réfrigération et (2) l'emballage sous vide et d'autres techniques dans l'industrie de la viande. Il est très probable que ces dangers soient réels à long-terme et même alors il est probable que la demande en papaïne reste stable chez les utilisateurs existants.

Il existe une tendance identifiable vers l'utilisation de papaïne séchée par atomisation contre la papaïne brute séchée au four. Cette tendance peut être fonction, en premier lieu, de la baisse de qualité des papaïnes brutes au cours des dernières années et, en second lieu, de l'existence de papaïne sous forme de poudre, séchée par atomisation, de haute qualité, en provenance du Zaïre, et, par conséquent, d'un besoin décroissant d'importer des préparations de papaïne purifiées de certains pays hautement industrialisés.

En ce qui concerne l'approvisionnement, le 'cycle de la papaïne' bien connu semble s'être rompu au cours des dernières années sous le choc de la nouvelle technologie de production de papaïne séchée par atomisation, des difficultés des cours internationaux, de l'inflation, de la maladie de la mosaïque à Sri Lanka (Ceylan) et de la dislocation de l'industrie en Ouganda.

La stabilisation à la fois de l'approvisionnement et de la demande peut être facilitée par l'établissement de conseils nationaux de marketing associé à des programmes pour l'amélioration de la récolte, du stockage, de l'emballage et du marketing.

RESUMEN

El mercado potencial de la papaína

El informe contiene cuatro capítulos. El primero trata de las características, funciones y utilización de la papaína, destacando su papel como enzima.

El segundo examina, con detalle, las distintas opciones técnicas posibles para los principales utilizadores industriales, y realiza una evaluación del uso potencial de la papaína en este contexto. El tercero describe los esquemas existentes y cambiantes del comercio mundial, apoyados por un análisis estadístico y un apéndice. El cuarto señala las dificultades para medir la actividad enzimática y como consecuencia para establecer medidas estándar universales. Se incluyen referencias y fuentes de información, y en un apéndice posterior se facilitan direcciones de firmas comerciales y nombres de utilizadores industriales.

El esquema actual de la demanda de papaína se presenta como una continuación del esquema histórico, con una ligera tendencia creciente. Los principales usos son, todavía, el tratamiento de la cerveza para evitar que se enturbie cuando se enfría y el reblandecimiento de la carne. Las perspectivas futuras de la demanda parecen indicar una tendencia creciente más definida que hasta ahora. El mayor potencial para el incremento del uso de la papaína reside en su utilización para el reblandecimiento enzimático de la carne y posiblemente también en la extracción de proteínas de pescado. Poco se sabe hasta ahora sobre esta última aplicación, existiendo sin embargo una popularidad creciente del reblandecimiento enzimático de la carne, la cual se ha reflejado en la legislación actual de varios países altamente industrializados, principalmente en Europa Occidental, Australia y Nueva Zelanda. Esta proceso legislativo se desarrolla lentamente. Los mayores peligros del creciente uso de la papaína residen en (1) la insolubilidad de la misma en el tratamiento de la cerveza y (2) en el envasado al vacío y otras técnicas de la industria cárnica. Estos peligros serán más probablemente efectivos a largo plazo e incluso entonces la demanda de papaína permanecerá probablemente estable entre los utilizadores existentes.

Existe una clara tendencia hacia el uso de papaíne en polvo secada por pulverización, en contra de la papaína cruda secada al horno. Esta tendencia puede deberse, en primer lugar, a la decreciente calidad de la papaína cruda en los últimos años y, en segundo término, a la disponibilidad de papaína en polvo, secada por pulverización de alta calidad procedente de Zaire, y por tanto la decreciente necesidad de importar preparaciones de papaína refinada por parte de ciertos países altamente industrializados.

En cuanto a la oferta, el conocido 'ciclo de la papaína' parece haberse roto en los años recientes por el impacto de la nueva tecnología para la producción de papaína en polvo secada por pulverización, las dificultades monetarias internacionales, la inflación, la enfermedad del mosaico en Sri Lanka (Ceilán) y la ruptura de la actividad industrial en Uganda.

La estabilidad del binomio oferta-demanda puede facilitarse mediante el establecimiento de comisiones nacionales de comercialización, conjuntamente con políticas para la mejora de la recolección, almacenamiento, envasado y comercialización.

Chapter 1

Papain defined, its characteristics and utilisation

1.1. PAPAIN: DEFINITION AND GRADING

Papain is one of more than 1 000 known individual enzymes[1] or protein substances produced by living cells which possess the ability to catalyse specific chemical reactions. The papain known in commercial trade is the dried latex from the fruit of the tropical fruit tree *Carica papaya L,*[2] and it is becoming increasingly important for producers to think of papain as an enzyme having a specific technological function rather than simply as the dried juice of the paw-paw. More care is advisable in future production of papain and for this reason another report is being prepared by the TPI which will discuss papain as an enzyme and provide guidance on processing and handling.

The name papain is also given to the active ingredient of formulated products, usually bearing a trade name, and it is used in addition by biochemists to denote the highly purified single enzyme prepared from the dried latex. In this report the definition of papain in use will usually be clear from the context.

Grading

Various quality grades have appeared on the market from time to time. Up to the mid 1950's, when the trade was dominated by supplies from Sri Lanka (Ceylon), three grades were known[3]: (a) fine white in powder form prepared by a specific process, (b) white oven-dried in crumb form, and (c) dark sun-dried papain in crumb form. Then up to about 1970 papain was commonly bought in two grades[4] (a) first or high grade oven-dried papain in powder or crumb form, usually creamy white in colour, and (b) second or low grade sun-dried brown papain in crumb form. First grade was often called East African No 1. This was latex collected as it dripped from freshly tapped fruit and then oven-dried, but there was also an East African No 2, which was latex coagulated on the fruit and scraped off after flow had ceased. This sub-grade, which was oven-dried, was darker in colour than East African No 1 and fetched up to 80% of the prevailing price for East African No 1.

Since 1970 other grades of papain resulting from new processing techniques[5] have appeared on the market. As a result papain can now be re-classified into three groups (1) crude papains, ranging from first grade white down to second grade brown, (2) crude papain in flake or powder form, sometimes referred to as semi-refined, and (3) spray-dried crude papain of higher activity in powder form, referred to as refined papain.[5]

In recent years, with the decline in supplies from Sri Lanka and Uganda, there has been a scarcity of first or high grade oven-dried papain with an enzyme activity of around 450–500 tyrosine units (see Chapter 4) and many

business houses complain that what is now being offered as first grade is no better than former second grade with an enzyme activity around 300 units. Papain in flake form is supplied from Zaire and in powder form from Tanzania, South Africa, Taiwan and Ecuador. The flake variety is prepared by oven-drying thin layers on plastic sheets, whilst the granular or powder form is also nowadays prepared by spray-drying techniques. Enzyme activity up to twice that of first grade crude papain has been claimed for flake, but some enzyme houses in the United Kingdom regard it as little better than first grade crude. Spray-dried papain in powder form, the third group mentioned above, is produced by a firm[6] in Zaire which now claims to supply 59 % of the world's crude papain equivalent, a percentage which could well increase if the decline in the quality of crude papain continues. Enzyme activity claimed by the marketing firm[7] is of the order of 800–1 000 units and sometimes much higher. Quality is discussed further in Chapter 3.

1.2. CHARACTERISTICS AND FUNCTIONS

These will be more fully described in the forthcoming TPI report mentioned above. Papain is a hydrolysing enzyme which breaks down proteins in aqueous solution. It is therefore classed as a protease (or proteinase, or proteolytic enzyme). It is a fairly mild enzyme, highly suited to its chosen uses, and because of this specificity it is possibly true to say that it has no really close substitutes, although it is one of a group of plant enzymes of closely similar characteristics, such as bromelain extracted from pineapple fruit or stems, and ficin from figs.

The usefulness of an enzyme in industrial manufacture depends on its activity, and care must be taken in production, storage and marketing to protect this activity. Papain, particularly in solution, is easily oxidised by exposure to air and is destroyed in aqueous solution either by temperatures above 70 °C for more than a few minutes, or by sunlight. It is easily inhibited by contact with metals such as iron, copper, zinc, and many others. Enzymes work best at a particular pH. They are destroyed below or above certain minima or maxima of pH. The higher the specific activity or rate of catalysis per unit weight of enzyme the more valuable it is because less is required to achieve a desired change. The activity can be increased by further processing and refining and the value thereby increased, as is realised by those producing the flake and powder papains mentioned above.

1.3. UTILISATION AND COMPETITIVE ENZYMES

Enzymes are used as technological tools or process techniques and not as edible substances. Generally they are used in[8]:

1. food and beverage preparation and animal feeds
2. pharmaceutical applications, primitive and modern
3. textile industries, and garment cleaning
4. paper and adhesives manufacture
5. medical applications
6. sewage disposal
7. research
8. analytical chemistry
9. miscellaneous uses

Papain finds use in each of these categories. For over 50 years its greatest use has been in the chillproofing of beer (see Chapter 2) and to a lesser

extent in meat tenderisation. In all cases papain competes with alternative technologies and/or alternative enzymes, chiefly the plant proteolytic enzymes bromelain and ficin, but also animal proteases, such as rennin and trypsin and several microbial (bacterial or fungal) proteases. Papain is usually preferred where (1) its specific action is more suitable than other proteases, (2) it is lower in price than competitors (it is much cheaper than bromelain or ficin, for example) and (3) it is cheaper and easier to operate than alternative technologies. The influences affecting potential papain utilisation are more fully developed in the next chapter. A list of uses is given in Table 1 Appendix B.

Chapter 2

Utilisation of papain by industry

2.1. DISTRIBUTION BY TYPE OF INDUSTRY

The distribution of papain utilisation by type of industry has been estimated[7] as follows: brewing 75%, meat 10%, fish 5%, other foods 5%, pharmaceuticals 2%, miscellaneous uses 3%. According to this estimate, therefore, 95% of papain is utilised in the food and beverage industries. The percentages may not be entirely accurate and they will fluctuate from year to year and vary from country to country, but on the whole the orders of magnitude can be accepted as reasonable. They are unlikely to change rapidly in the next few years.

2.2. THE BEER INDUSTRY

2.2.1. Consumption and production patterns

About 14 850 000 000 imperial gallons or 675 000 000 hectolitres of beer were consumed throughout the world in 1972,[9] most of it in highly industrialised countries such as the United States, European countries, and Japan. Consumption in developing countries is, however, widespread (see Table 2) and although *per capita* consumption (Table 2) is much lower than in developed countries the patterns of taste and consumption in the more affluent cities and towns in the Third World are similar to those in developed countries. Most beer is produced in consuming countries (compare Tables 2 and 3) although there is a growing export of canned beer both to countries brewing some beers and to countries lacking breweries. Sales performances by large firms such as Skol International[10] have shown a marked improvement in recent years as new markets are extended in developing countries.[11] Interstate movement in large quantity of a liquid such as beer is not favoured on grounds of transport economics. Many major brewing companies with an eye to markets abroad, prefer either to allow breweries abroad to produce their product under licence or alternatively to part-own or wholly own breweries in foreign countries. This increasing interest in foreign markets holds some implication for papain utilisation. Demand for beer in the United Kingdom has been growing at an annual rate of about 2·5%[12] and this slow steady trend is expected to continue. In developing countries the rate of growth is expected to be greater.

Beer is defined[13] as 'an alcoholic beverage made by the fermentation of a farinaceous extract which is obtained from a starchy raw material, barley'. It is possible to replace some part of the barley with other starchy materials called adjuncts,[14] such as maize, rice, wheat, oats, potatoes, sorghum, cassava, soyabeans, sugar. Again there is some implication for papain utilisation. In many parts of the developing world these carbohydrate sources may be cheaper and more accessible than barley, and consequently there may be an economic incentive to add more adjuncts supplying prin-

cipally starch which is fermented by the yeast to produce alcohol. Altering the carbohydrate balance must, however, be undertaken with economic caution.[15]

It is possible to make a beer wholly without barley, such as an all-rice beer, but this is a highly localised practice. In contrast, brewers in the Federal Republic of Germany (West Germany) are forbidden the use of adjuncts in bottom-fermented beers (lagers) under the current Beer Excise Act which originates from a Bavarian decree passed in 1516, the so-called 'Purity Act' (Reinheitsgebot).[16] Under the current act the use of papain in beer for consumption in West Germany is forbidden. Within the European Economic Community (EEC) any law which inhibits freer trade is against the spirit of the EEC and considerable pressure may be brought by other members of the Community for modification of this law. Such modification could lead to conditions under which a greater utilisation of papain both for beer chill-proofing and for 'raw grains' extraction at the mashing stage (section 2.2.3) would be possible. Agreement on legislation is, however, likely to take some years and the necessary alterations in processing some further years, and even then any increased use of papain arising from these eased restrictions may not be great. New breweries outside Europe may be more likely to adopt the use of papain.

2.2.2. Effects of types of beer on papain utilisation

The various types of beer are usually classified as:

(1) lagers or stored beers, light bright clear beers such as Pilsener, Dortmund, Skol, preferred in the United States, Europe, Japan and increasingly throughout the world;

(2) ales, light beers preferred in the United Kingdom (although demand for lager is increasing) and also in some former dominion territories, for example, Canada and Australia; and

(3) dark beers such as porter and stout (some lagers, for example, Munich lagers are dark also) marketed in West Africa, Malaysia and elsewhere.

Lagers account for over 80%, and together with ales, probably 90% of the world production of beer. Increasingly throughout the world, possibly under the social leadership provided by beer drinkers in the United States, these beers are being consumed ice cold, or, more usually, chilled in refrigerators in the home or in the retail outlet.

It is these light clear beers which are of interest for papain utilisation because it is the use of papain or an alternative method (see below) which maintains the clarity (and therefore in the consumer's mind the freshness and, some would say, the taste) of beer when chilled. Light, bright, clear, ice cold or chilled beer tends to become virtually the universal standard beer drink of today whatever the brand. In economic terms consumer sovereignty reigns in the beer industry, and this very heavy consumer dependence places severe processing constraints on the producing industry.

2.2.3. Beer technology and the impact on papain use

The clarification and preservation of clarity of beer can take place as separate process stages or during the major beer processing stages, which are malting, mashing, fermentation, storage (lagering), bottling and canning or racking. Process problems arise with the development of non-biological beer hazes[17 18 19] such as metal haze, oxidation haze, and chill haze. The first two are corrected by various processing techniques such as filtration and CO_2 treatment. It is only chill haze, developed when beer is chilled after processing, which concerns us here.

The core of the chill haze problem lies in the formation of protein-poly-

hydric phenol (polyphenol) or protein-tannin complexes during brewing. These complexes are insoluble and eventually form a visible permanent haze. If the beer is then chilled a more intense haze known as chill haze develops.[19]

Different solutions to the problem are adopted by different brewers who now have a wide range of technological options available to them.[20] These include papain treatment and are briefly:

(1) extraction of polyphenols, by adding one of the following:
 (a) tannic acid, a method favoured in France, Belgium and Africa, and by some brewers in the United Kingdom;
 (b) a synthetic polymer, polyvinyl pyrrolidone (PVP)[21] marketed as Polyclar AT,[22] a method popular in the United States and United Kingdom and nowadays usually added in the insoluble form which can be removed and re-used (an economic advantage);
 (c) a Polyamide resin, Nylon 66,[22] also commonly used in the United States and United Kingdom, and which is also insoluble;
 (d) a diatomaceous earth such as kieselguhr or Fuller's earth in a filtering process; and
 (e) a filter sheet impregnated with Nylon 66[22] in a filtering process.
 Other methods are also used, but the choice usually lies between PVP and tannic acid which are both efficient, easy to use and economical.

(2) extraction of proteins, which in many cases is easier than polyphenol extraction and for which even more technological options are open to the brewer, including:
 (a) adsorbents, silicic preparations such as silica gel or hydrogel which are very popular, or bentonite, and
 (b) proteolytic enzyme preparations, usually papain-based and often including bromelain and/or ficin and stabilisers and other additions. An alternative enzyme sometimes used is pepsin, but papain is preferred on several grounds: it is cheaper, it is more selective in its action in that it is unlikely to produce bitter peptides from excessive protein breakdown, and it seems more appropriate to use papain, a plant enzyme, rather than pepsin, an animal enzyme, in a plant product (barley extract) in a heavily consumer-oriented industry.

(3) treatment at the mash stage by using either
 (a) formaldehyde to remove polyphenols, coupled with the addition of gel at the filtration stage, usually called the 'belt and braces' technique,[23] to doubly ensure shelf-life and stability or
 (b) a proteolytic enzyme process,[24] an approach still largely at the pilot test stage but one which holds some potential for increased utilisation of papain.[7,19,20,23,25]

It is clear that papain is in highly competitive circumstances here and the influences affecting the final choice of technology are many. The beer industry is, of course, an old-established one[13,26] and technological innovation has taken place only very gradually. There has been a large measure of industrial inertia associated with invested capital, established personnel, and known, tried and proven processes which have given satisfactory if not perfect results. Deviation from proven processes introduces risk probabilities. These have, in recent years, been reduced by scientific research closely oriented to market needs[27] and as a result the beer industry is now more amenable to technological change than formerly.[28] However this does not mean that the use of papain has been identified as the most outstanding technique. Rather the contrary tends to be the case; that research has thrown up over the years a range of substitute technologies as outlined above and some of these have penetrated existing and potential papain markets because they fit more easily into some existing process systems,[19,23,25,29] even though in some cases they might be more expensive.

Newer processing countries such as Japan have not opted solely for the enzyme process and other technologies have been introduced there as well.[20]

The use of papain for chillproofing has been long established in the United States, indeed since 1911 when Wallerstein took out patents[30] (after a research programme which reflected the beer industry's concern at that time for the effects of structural changes in the industry — mergers, for example — increased market size and the need for longer shelf-life arising out of improved transport and refrigeration). However, even in the United States, which is the largest user of papain, other technologies are employed and therefore a balanced perspective must be maintained with respect to potential papain use. No sweeping technological changes can be expected in the next decade.

2.2.4. Structural changes in the beer industry and their impact

A further constraint on the use of papain, and one which may play an increasingly important role, is space. Papain needs sufficient time to work in the beer and storage space is therefore required. Storage can be an important cost in a consumer-oriented industry and there are strong pressures on management for more frequent utilisation of time, equipment and space in an industry which is essentially still a batch processing one.

Brewers in heavily urbanised areas find such pressures acute.[23] At the other extreme some brewers in more favoured locations are able to achieve clarity and stability through long-term (several weeks) lagering, and for these the use of papain is either not necessary or is necessary only in small amounts. The storage aspect is best viewed in conjunction with the required shelf-life of beer. Generally speaking little or no papain is added for short-life quick-sell beers, for example draught beers in the United Kingdom; a small amount is added for a shelf-life of three to six months, for example, for keg beers; and a greater amount is added for those beers, such as export beers and canned beers, where shelf-life conditions are outside the producer's control and beer may be required to last up to two years.[31] Dosage rates vary from about one-tenth oz per 36 gal barrel (1·73gr per hectolitre) to about one-fifth oz per 36 gal barrel (3·46gr per hectolitre).

Producer control over shelf-life has been increased through improved access to markets as a result of better distribution systems, ownership of public houses, and promotion of beer drinking clubs. In addition, structural rationalisation (mergers, take-overs) in the industry in the United States fifty years ago and in the United Kingdom in the last twenty-five years has reduced the number of firms, increased the size of firm, markedly enlarged the size of markets for the enlarged firm, and increased the size of new breweries.[9, 26] In the United Kingdom seven major firms, the Big Seven, now share 75% of the market and eighty-one smaller firms the remainder. The increased market size has increased the concern for shelf-life as it did earlier in the United States[30] and there is resulting pressure for existing papain users to use a little more papain. Coupled with this in the United Kingdom there has been a dramatic change in consumer tastes. In particular, new drinkers are turning away from traditional draught beers from the local brewery to pale and light ales in keg from more distant breweries and to lagers in bottles, cans and kegs (see Table 4).[9] These interacting pressures of increased market size and type of beer have induced a greater utilisation of papain and the trend, a slow one, can be expected to continue at the same rate in the United Kingdom. (Official statistics cannot unfortunately illustrate this as the industry imports highly refined papain preparations from the United States in addition to domestic preparations and these imports are not shown separately in the Trade Returns).

Structural changes such as those which have taken place in the United States and United Kingdom might also be expected in the industry in the

EEC, especially in West Germany which in 1971 still had 1 680 brewing companies and 1 777 breweries, and Belgium, a small country with 162 companies and 206 breweries.[32] Switzerland, Austria, Czechoslovakia and Poland have similar structures. There have been some mergers in Germany in recent years[9] and in 1973 United Kingdom firms have been buying into the German brewing industry.[33] This type of rationalisation especially if combined with amendments to the Purity Law could lead to increased papain utilisation in West Germany, possibly up to United Kingdom level over the next ten to fifteen years.

2.2.5. Insolubilised or immobilised papain

Mention must be made finally or insolubilised or immobilised papain, a technique which allows the recovery of papain from the process for re-use. Several patents exist for this process, for example Barker[34] and others.[35] Although a form of immobilised papain has been used in trials, immobilisation has not yet been perfected. A consensus of informed opinion gathered from the interested industries, beer, and enzyme preparers, indicates that perfection and commercialisation are still a long way off, at least five years, most likely ten years, but possibly fifteen to twenty years. With large molecules such as those of papain it is particularly difficult to design a support and linkage which does not restrict the access of the protein to the enzyme which is essential for enzyme action. However, it is always possible for the technologists to achieve a lucky break-through and should this happen it could present probably the greatest threat to total papain utilisation. This prospect must be balanced against the fact that in beer processing one can get away with a crude enzyme which is cheap rather than introduce an immobilised enzyme which requires additional equipment and which must be recovered and checked.[20] Industrial inertia will also inevitably play a part so that on balance any real threat to papain utilisation must be in the very long term.

2.2.6. Conclusions

The various pressures on usage of papain are listed in the panel below for convenience. An assessment (plus or minus) is made as to whether resulting increased or decreased use has been experienced in the past or is

Row	Factors affecting utilisation of papain in the beer industry	Assessment (+ −) Past	Future Short	Long
1	Increased demand for bright beers in the United States	+		
2	Structural changes in the United States beer industry	+		
3	The Wallerstein patents, 1911	+		
4	Continued increased demand for bright beers, world wide	+	+	+
5	Faster than average increased demand for bright beers in developing countries		+	+
6	Structural changes in United Kingdom beer industry	+	+	+
7	Changing demand to bright beers in United Kingdom	+	+	+
8	Structural changes in the EEC beer industry			+
9	'Purity Law' in West Germany and possible amendment	−	−	+
10	Alternative processes	−	−	−
11	Alternative enzymes	−	−	−
12	Immobilised papain			−
13	'Mashing-in' process		+	+
14	Long-term lagering	−	−	−
15	Export and canned beers requiring longer-life stability	+	+	+
16	Scarcity of storage and lagering space in urbanised areas		+	+
17	Dramatic increase in world prices for grains		+	+
18	Growing anti-enzyme lobby in the United States			−

likely to be experienced in the short term or long term. It is impossible in the current state of knowledge to quantify these and any others which may exist. The usage of papain has shown a small steady increase over the years (see Section 3.5) ; this trend is expected to continue over the next four or five years, but thereafter a larger rate of increase is thought likely to occur. Regional increases in demand in the EEC and parts of the developing world could become significant in the long term, but within a gradual overall growth pattern. Immobilised papain could present a very real challenge in the very long term.

2.3. THE MEAT INDUSTRY

2.3.1. Consumption and production pattern

Fresh meat is the principal status food of the Western diet.[36] World production of fresh meat in 1970 was 98 million tons and is projected to increase to 131 million tons by 1980.[37] These figures include beef and veal, mutton and lamb, pig meat and poultry meat and their products. They do not include other meats such as goat,[38] reindeer, water buffalo,[39] wild African buffalo, elephant, antelope, and other edible animals of the tropical grasslands. None of these except goat and reindeer is bred or reared for meat production[40] at the present time and all are capable of being tenderised with papain.[41 42]

2.3.2. Factors and techniques affecting meat tenderness

Tenderness is the quality rated by the average consumer in the Western world as the most important attribute of meat.[43 44 45 46] This may not be the case elsewhere. In Thailand, for example, Western concepts of grading beef according to tenderness, marbling and quality do not apply.[47] Tastes do change with increasing incomes and increasing standards of living, but for most of the developing world this is a very slow process.

Up to the present time less than 1 % of the estimated world production of meat is tenderised by the use of proteolytic enzymes, principally papain. It would seem therefore that there is a vast potential for increased papain utilisation. In fact enzyme technology, as in the beer industry, is only one amongst a wide range of technological options available to the meat industry and, as in brewing, combinations of various techniques are often employed to achieve a desired product. As in brewing also, the well-tried long-established techniques continue to dominate, often because they present a lower risk probability and sometimes because they may be cheaper. However, consumer orientation in the industry's products becomes daily more acute and pressures are now appearing, especially in developed countries, for increased consumer acceptance and a lowering of production costs by the introduction of new technology. There is therefore an increasing readiness in the industry to look more closely at enzyme technology.

Tenderisation methods and factors affecting tenderness are distinguished as ante-mortem or pre-slaughter, and post-mortem or post-slaughter, and within the latter group pre-rigor (mortis) and post-rigor treatment is an important distinction. In general the pre-slaughter factors which affect tenderness do so by determining the amounts and distribution (texture) and the type of connective tissue[45] containing collagen and elastin. Post-slaughter techniques aim at breaking the cross-linkages between these fibrous proteins[46] or at breaking up the meat into shreds or small portions.

The most important factor affecting tenderness is species.[45] Pork meat for example contains less connective tissue than beef and is usually considered to be tender without treatment. The second most important factor is the difference, within an individual carcase, of tenderness between some parts and others. Whatever the species may be, whether beef, pig, sheep or other

species, about 45 % of any carcase (see Fig. 7) represents the high-priced tender cuts[48, 49] which require no tenderisation given conventional pre- and post-slaughter handling. The remaining 55 % of the carcase is usually tougher and requires some tenderisation even if it is only prolonged cooking.

2.3.3. Pre-slaughter factors and techniques

2.3.3.1. *Age at slaughter*

Apart from species and carcase differentials the pre-slaughter factors and techniques affecting tenderness include: age of the animal at slaughter, breed, feeding, heredity, sex, conformity, slaughter-house practices, and enzyme technology. There is general agreement[44, 45, 50, 51] that the age of the animal at slaughter is the most important of these. The older the animal the tougher the meat usually and the greater the need for tenderisation. The other factors are much less important influences on tenderness, but potentially good meat can be impaired by poor animal husbandry and bad slaughter-house practices.[50, 51, 52] Excitement at slaughter for example and inefficient killing can lead to spoilage.[52]

In the great meat-eating countries (see Table 5) most of the annual slaughter takes place at an early age and with efficient methods and there is little real need for tenderisation of the high-priced cuts. For low-priced cuts, for older beef and for cows, tenderisation can be advantageous.

Cows in the United Kingdom make up only 17 % of the total slaughter[53] and are sometimes channelled into the meat processing industry rather than the fresh meat market and may be given post-slaughter tenderisation treatment there. The percentage is probably similar in other countries, but may increase in the short term in response to world-wide beef shortages and milk surpluses accompanied by high production costs. More cows may be taken out of dairying in the short term and this may increase the pressure for enzyme tenderisation.

A more important factor in the United Kingdom and probably also in the United States is the recent dramatically increased cost of grain-feed and cattle-feed which has encouraged a move away from intensive feeding systems to grass systems. This change could push up the average age at slaughter in the short term from two years as at present and generate in the meat industry an atmosphere more favourable to a rapid take-up of enzyme technology and wider acceptance of it. In the United States, where the annual slaughter is ten times that of the United Kingdom and consumer preference for tender steaks far more acute, the increased demand for enzyme tenderisers could be substantial.

Some 80 % of beef production in North America is based on feed-grains.[54]

In the long term the outlook is different. The agricultural technology is now proven, and its application is being promoted in the United Kingdom for the production of prime beef in 18 months on grassland systems.[56, 57] The time-lag in widespread application of this new knowledge will cover several years, but the techniques will certainly be adopted where there are efficient farming systems and as long as feed prices remain high.

2.3.3.2. *Enzyme tenderisers*

Pre-slaughter enzyme tenderisers which have been patented include (a) plant proteases such as papain, bromelain and ficin; (b) animal proteases such as trypsin[58] and (c) fungal enzymes, examples of which are Rhozyme,[22] Hydralase,[22] and E30.[22] Papain has been the most used pre-tenderiser since the method was patented[59] by Beuk in 1959. The patent was taken up by Swift and Co. in the United States and two products have been commercialised by them under the brand names PROTEN[22] and TRUTENDR.[22] The first of these, the top brand, is used to tenderise prime steers and heifers

while the other brand is used on lower quality beef in the United States only. The process is simply the injection of a solution containing papain into the animal's jugular vein from two to thirty minutes prior to slaughter. The animal's blood-stream transports the solution to all parts of the body, achieving the efficient distribution which is impossible in post-slaughter injection. The enzyme action of papain does not occur until the meat is eventually cooked by the consumer.[41 60]

Swift and Co. claim[41] to be tenderising 3% of the supply to the United States national market with their two brands. Only PROTEN is used at present outside the United States, and only under licence from Swift and Co. This firm has undertaken an extensive campaign to expand sales and licensing rights. In the United Kingdom, where enzyme tenderisation is permissible, about a dozen abattoirs are pre-injecting a proportion of their slaughter on behalf of Swift and Co. In other European countries, for example West Germany where enzyme use is not permitted by law, only mechanical methods of tenderising are employed post-slaughter (see below). Swift have, however, carried out trials for the Governments of Belgium, West Germany and Italy, and have negotiated trials for Russia, Poland, Hungary and Czechoslovakia, countries where the condition of the animals is said to be poorer than in Western Europe.[41] Such vigorous sales promotion can be expected to have an effect, but legislation within the EEC could be a slow process and take many years. In Australia Swift have also made approaches and claim[41] to have a national acceptance for the introduction of papain. The State of Queensland is purported to be very keen, but New South Wales has prohibitive legislation.

Sales promotion is currently in progress in the Far East and some limited experimental work has already been done by Swift in Africa in tenderising game. The potential of the PROTEN process for these developing regions is enormous, but the prospects for realising this potential are not good for two groups of reasons. Firstly, the technique is sophisticated, needs considerable know-how with regard to dosing and injecting, and therefore requires substantial back-up services, veterinary expertise and a reliable supply of enzyme of the required purity. It is not therefore an attractive commercial proposition where populations are poor and unable to meet the resulting increased cost of meat. Secondly, and of more importance, are the current priorities in developing countries. These countries are at present involved in infrastructural problems, the establishment of meat industry enterprises, the improvement of livestock standards, the sanitary conditions in existing slaughter houses, the up-grading of meat handling and preservation, the utilisation of inedible by-products, and international as well as national meat marketing.[61] They are not likely to be interested in enzyme technology for many years to come, except possibly for those developing countries producing beef for export.

One of the handicaps working against the PROTEN process at present is the markedly uneven quality of papain supplies. For each injected dose consistently uniform enzyme activity is required so that animals will react predictably and the risk of anaphylactic reaction is avoided. Animals can collapse and die in acute distress in fifteen minutes if the dosage is not correctly determined. About 80% of the samples of papain offered to Swift are rejected by them because of low enzyme activity and lack of consistency. This demand for uniformly high quality papain is spreading also to other industrial users. Producers will find it more and more difficult to obtain acceptable prices if they are not able to meet required standards of quality.

An alternative enzyme of microbial origin for pre-slaughter injection is currently being researched[46] and could prove to be a real competition for papain if successful. The objective in this case is to accelerate post-slaughter conditioning which itself is a tenderising technique (discussed below). Competition from this source could take many years yet. The process will

have to prove itself in use and gain acceptance in the industry. This could take a long time and many countries may decline to authorise the use of a bacterial enzyme.

2.3.4. Post-slaughter factors and techniques

Post-slaughter methods of tenderisation include: ageing, conditioning, hanging by the Achilles tendon, hanging by the aitch bone (tenderstretch), chilling and freezing, vacuum packing, mechanical means such as chopping, mincing, tumbling, and non-mechanical methods such as enzyme treatment, marinading in wine, vinegar or salt, and, of course, cooking.

Once again enzyme technology is only a competitor amongst these options but may be used in combinations with one or more of the other methods.

2.3.4.1. *Enzyme tenderisation*

The big problem, as mentioned above with post-mortem enzyme treatment, has been the distribution of the enzyme throughout the meat so that it comes intimately and evenly into contact with all of the relevant tissues. The methods of applying papain and other enzyme solutions are:[41 62 63 64]

(1) dipping or immersion of thin meat-cuts in a bath of solution, a method usually employed in steak houses and restaurants and usually assisted by piercing the meat with a fork

(2) smearing or spreading on the surfaces of meat-cuts

(3) spraying the solution by aerosol on to thin slices of meat

(4) wrapping the meat-cuts in paper impregnated with papain solution

(5) rehydrating freeze-dried meat with papain solution

(6) injection by hand with a single needle into a block of meat

(7) injection by multi-needle machine into a block of meat

In all of these methods the enzyme only becomes active in cooking and in all of them the meat immediately in contact with the enzyme is well tenderised and often becomes too soft and mushy on cooking, while the remainder of the meat may not be affected. One advantage of these methods is that they can be applied selectively, that is, to tougher meats requiring tenderisation, for example the tougher parts of the individual carcase and meat from older animals and cows. They also allow the removal of high-priced cuts from prime carcases before application to the tougher remaining parts.

The methods have been in use longer than the pre-injection method which was intended to replace them since it was believed to be more efficient. In practice, however, all of the methods are still used and in some respects they are complementary.

Another newer method is now being marketed by Swift and Co. It is a spray-injection method, a process in which hollow needles are pushed into the meat and cheap nitrogen gas blown through these needles into the meat. When the needles have fully penetrated tenderiser is pumped in. The gassed areas absorb the tenderiser and provide better distribution of the enzyme than the previous single and multi-needle machines.[63] This new machine has been used by Swift in the United States for about five years and is now being produced under licence for the United Kingdom market.[41 63 65] The machine is intended to supersede single-needle and multi-needle machines as well as the immersion, smear and other methods. It is however likely to be more suited to large-scale production and the existing methods may prevail for many years.

If the new method proves to be more efficient than the old it would be

reasonable to expect a wider acceptance of enzyme tenderisation and therefore greater utilisation of papain.

Both bromelain and papain are used in the process, sometimes together and sometimes separately, but since papain is cheaper it can be assumed that much more papain is used than bromelain. Here again, quality becomes increasingly important for consistently uniform and predictable results.

2.3.4.2. *Combining technologies: enzyme treatment and meat tumbling*

The concept of combining an enzyme tenderiser with a mechanical system has been given a recent application in meat tumbling which is the 'massaging of meat surfaces with a meat mass'[66] or simply the rubbing of meats against each other in a tumbler. (A variant on this is impact tumbling.) This technique combines single- or multi-needle injections with immersion for a maturing period in a brine solution followed by tumbling. It is not specifically a tenderising technique. It aims at bringing the meat proteins, especially myosin, to the surface where they bond the meat portions together in one mass. To ensure tenderness papain has, in some cases recently, been added to the process. The method is reportedly gaining in popularity and is a source of potential papain utilisation which could increase in significance, over the next few years.

The methods of enzyme use outlined above prevail only in the United States and the United Kingdom on a wide scale and to a small extent in Canada and for export purposes in Australia. Commercial usage is forbidden practically everywhere else.

2.3.4.3. *Domestic tenderiser versus mechanical tenderiser*

Application of domestic tenderisers is permitted almost everywhere, but has not gained wide acceptance. In Europe mechanical needle methods are mostly used without the addition of enzymes, and even though domestic enzyme preparations are allowed the general public attitude is that meat offered over the counter should be tender anyhow, and if it is not, then mechanical tenderising methods such as mincing, chopping and needle methods will suffice. In Australia mechanical means are common. Enzyme tenderisers for domestic use are sold in supermarkets and delicatessens, but the marketed products have not been able to achieve any marked degree of public acceptance. The quantities imported are insignificant. Occasionally some small amounts of meat are enzyme tenderised for export to the United States to fill special orders, but now that the United States is becoming a major importer of meat these amounts may increase. Against this, chilling for export to Japan has become a major trade,[69] and the same could be applied to American exports.

2.3.4.4. *Ageing and conditioning*

Ageing of meat is generally recognised as the most successful and most widely used method of tenderisation.[51 70] Meat held in storage after rigor mortis has set in for periods varying from six to twenty days (and in bacterially controlled conditions up to seventy days)[70] increases in tenderness.

A variation on this is conditioning which can be achieved by chilling or freezing. This must be done post-rigor to avoid cold-shortening, or contraction of the meat which increases toughness if carried out pre-rigor.

In New Zealand a proportion of the lamb kill now combines ageing with deep chilling or freezing and this combination of methods to avoid cold-shortening is considered to be a better approach to meat tenderisation than either ageing alone or artificial tenderisers.[71] There seems no likelihood of enzyme technology being taken up in New Zealand for many years to come in the light of this philosophy. The potential for papain use would otherwise be enormous.

Variations of the ageing or conditioning techniques are (1) high-temperature ageing employed to some extent in the United States and in New Zealand for lamb exported to the United States[72] and (2) packaging in gas-permeable film, a method introduced in Australia,[51] but not yet used to any extent. The point here is that the number of technological alternatives preferable in any areas to enzyme technology is increasing and the potential for papain is to that extent decreasing.

2.3.4.5. *Cold storage costs, accelerated conditioning, and vacuum-packing*

High storage costs (especially in high land-cost urbanised areas) associated with long hanging periods and refrigeration bring pressure to bear on abattoir management for shortening the ageing process or for accelerating the conditioning process, or both. In addition to high cost pressure the added pressure of keeping the market supplied has meant that carcases have been moved out of storage to the retailer within 48 hours rather than 6 to 20 days. This has sometimes resulted in potentially prime quality meat reaching the consumer insufficiently aged or conditioned and therefore not tender. Worse still from the consumers' point of view, it has become easy for unscrupulous suppliers to pass through the distribution systems the occasional tough carcase of old animal or a cow which would be very difficult to distinguish from prime steers slaughtered on the same day.

The principal methods of attacking the problem of high storage costs are:

(1) preinjection using the PROTEN[22] papain process aimed at tenderising the meat on cooking

(2) preinjection using a microbial enzyme[46] aimed directly at accelerating the conditioning process in storage and

(3) vacuum-packing.

In high storage cost areas the PROTEN process certainly becomes more attractive and is already available. On the other hand the microbial enzyme is not yet commercially available, but could well be preferred as a solution to the storage-cost problem in the long run. Market penetration by both of these technologies could, however, be severely restricted by competition from vacuum packing.[73,74]

Vacuum packing at present accounts for 7·5% of total beef sales in the United Kingdom[50] and has gained wide popularity in the United States, Canada, Argentina, Uruguay, Brazil, Germany, France, Belgium, Italy, Ireland and Australia. Vacuum-packing extends shelf-life up to six or eight weeks and allows conditioning to continue within the pack, even over long transport journeys such as those from Australia to Japan.[69] Drip losses are reduced and abattoirs are able to move meat directly after packing to the butcher and thereby avoid storage costs.

The technique is bound to present very strong competition to enzyme tenderisation. It can be expected to increase in importance fairly rapidly if it is not inhibited by scarcity of supply and the high price of petroleum-based plastic film for packing as well as the scarcity of cardboard containers in a context of world pulp and paper shortages. According to at least one informed opinion[49] abattoirs in the future will produce not only vacuum packs for final cutting on the butcher's block, but will supply the retail joints, portion-size, for the consumer in vacuum packs as well.

Vacuum-packaging of this kind might well replace the need for post-slaughter enzyme tenderising of the dip, smear, needle and other types. It is at present confined mostly to the high-priced parts of the carcase and is aimed principally at the consumer able to pay for high quality meat. To some extent therefore the PROTEN[22] and post-slaughter uses of papain when applied to lower quality meats could be complementary to vacuum-packing in the future and competition could be avoided by this kind of rationalisation.

In Australia vacuum-packing has been in use for the domestic market for about twelve years, but recent years have seen a rapid increase in export of vacuum-packed meat to Japan, a trade facilitated by containerisation and expected to expand even more.[72] At present it is 'guessed' that only about 5 % of Australia's meat is tenderised by vacuum-packing and 'tenderstretch' (see below) combined. A significant growth is expected over the next two to five years as domestic distribution of vacuum-packing expands and the use of the 'tenderstretch' technique becomes more popular. There is the added advantage that no additions of a chemical nature are included in the meat and the system of vacuum-packing provides one of the few cases where the quality of the product actually improves during the shipping period.[72]

2.3.4.6. *Hanging techniques: 'tenderstretch'*

'Tenderstretch' is a simple process of hanging carcases by the aitch bone before rigor mortis sets in instead of the traditional method of hanging by the Achilles tendon.[51, 72] This method allows a greater relaxation of certain muscles and achieves significant improvement in tenderness of the high-priced cuts (illustrated in Figure 7). It is likely to gain wide favour domestically in Australia and combined with vacuum-packing make the use there of enzymes for prime quality beef unnecessary.

There would still be a potential papain market for older tougher animals and for the tougher parts of prime carcases, but the National Health and Medical Research Council has not yet approved the use of ante-mortem or post-mortem enzymes except for export and seems unlikely to do so for a long time to come.

2.3.5. Conclusions

The world meat industry is an extraordinarily complex one involving many countries and many species of animal. Economic developments in one major producing country or in relation to one species can have enormous repercussions in all other spheres, as for example the decision by Argentina in recent years to curtail its beef exports. Interactions such as this also affect meat tenderisation and the potential for papain utilisation.

The species most requiring tenderisation is beef, especially the non-grain fed section of the industry. In the current unfavourable economic climate of high beef production costs and reduced price levels the production of beef could decline or remain roughly constant and the potential for enzyme tenderisation may for this reason not expand in the short-term.
Against this, however, must be weighed the effects of switching from intensive grain feeding to grassland feeding which in the short-term must increase the need for tenderisation. The balance between these influences must lean towards increased enzyme usage. The longer term could see the swing reversed, but if enzyme usage becomes established in the short run it will probably be retained when production economics become more favourable.

The greatest potential for increased use of papain is certainly in the meat industry and particularly in developing countries. However the constraints on realisation of this potential are very strong. Beef consumption in the United States, the largest enzyme user, has probably come close to saturation point except in the lower income groups where income is increasing. In the United Kingdom papain use seems to be increasing, but the factors affecting the unsettled state of the beef market probably balance out to leave the short-term demand for papain as it is at present. Throughout the rest of the world enzyme usage is either prohibited by law or little known, and other technologies especially ageing, conditioning in cold storage and vacuum-packing are preferred. In developing countries the priorities at present favour infra-structural improvements in the meat industry, and incomes are in any case low.

The summarised opinion expressed here is that the three major influences of high production costs, an increasing age at slaughter and promotional sales programmes initiated by Swift and Co., must have a positive effect leading to at least a small increase in papain use in the short run. In the long run when established the technique will prevail along with other techniques and be used in a rational way to assist other techniques, thus ensuring a steady increase in papain use.

In the longer term permitting legislation may be passed in such countries as Australia, and perhaps also in Europe, to be followed by similar legislation in developing countries as *per caput* income, hence meat consumption rises. In general the continuing outlook for papain in the meat industry seems to be an optimistic one.

Row	Factors affecting utilisation of papain in the meat industry	Assessment (+ −) Past	Future Short	Long
1	Consumer preference for very tender steaks in the United States	+	+	+
2	The BEUK patents taken up by Swift and Co.	+	+	+
3	Sales promotion by Swift and Co.	+	+	+
4	Improved animal husbandry in affluent countries	−	−	−
5	Lack of good animal husbandry in some developing countries			+
6	Increase in meat exports from developing countries			+
7	Improving animal husbandry in some developing countries			−
8	Species differences, for example, beef as opposed to pork	+	+	+
9	Carcase differences, low-priced cuts as opposed to high priced	+	+	+
10	Availability of domestic tenderisers	+	+	+
11	Mechanical tenderisers	−	−	−
12	Mechanical tenderiser combined with papain tenderiser	+	+	+
13	New machine combining mechanical and enzyme methods		+	+
14	Changing tastes with increasing incomes and standards of living	+	+	+
15	Low incomes and low standards of living	−	−	−
16	Lack of sophisticated technology	−	−	−
17	Post-slaughter ageing of beef in storage	−	−	−
18	Post-slaughter conditioning in storage	−	−	−
19	Accelerated conditioning by microbial enzyme			−
20	Demand pressure on distribution systems and cold storage space in urbanised areas		+	+
21	High storage and refrigeration costs in urbanised areas		+	+
22	Other enzymes	−	−	−
23	High cost of other enzymes	+	+	+
24	Poor quality of papain	−	−	−
25	Increasing average age of animal at slaughter		+	
26	Increased cost of grain and animal feed		+	+
27	Slaughter of part of dairy herds in milk-surplus, high feed-cost countries		+	
28	Improving grassland technology			−
29	Vacuum packing	−	−	−
30	Carcase hanging methods	−	−	−
31	Other technologies (high temperature ageing, gas)	−	−	−
32	Complementary rationalisation of methods related to specific needs and markets	+	+	+
33	Increased cost of meat production coupled with reduced price levels		−	−

2.4. FISH AND OTHER FOODS

2.4.1. Fish

The use of papain in fish protein extraction is reported[7, 75, 76] as a new and expanding application in France where the amount of papain used for this purpose is said to equal all other uses in France. Waste from the fresh edible fish industry is used together with other inedible marine species taken in the fishing nets and previously thrown back into the sea.

About 10 000 tons of this protein are now produced annually in powder form and marketed to replace milk in the diet of calves. There is a big market in such European countries as France, Germany, Switzerland and Austria for milk replacers and the two producing plants are also exporting to the United Kingdom, Spain, Italy, Yugoslavia, Poland and the U.S.A. The process is not as yet applied elsewhere, but the prospects seem bright. Skim milk is scarce and expensive in some countries and may become increasingly so if dairy herds are reduced. The need for milk replacers might then become acute in some countries. This is the feeling of the producers of the fish protein who also think that in the future milk will have to be reserved for use as a human food and therefore fish protein will become more important.

In the United Kingdom, the United States and elsewhere firms are interested in this process, but at present other technologies for protein extraction are dominant and the profits from other enterprises such as fish meal appear to be sufficiently acceptable for firms simply to hold a watching brief for the present.

The quantity of papain involved here is very small, perhaps a hundredth part of one per cent per ton of raw materials or even less. The potential for papain use is, however, considerable.

2.4.2. Other foods

Other foods in which papain is used at least experimentally include dehydrated pulses and beans,[77] baked goods, baby foods, cheese, non-clotting margarine, chewing gum and animal feed. In general the attitude towards this group of uses is that papain can be used, but in all cases has to compete against other more acceptable technologies, other cheaper enzymes, or, as in the case of cheese, other more suitable enzymes, in this case rennin.

Papain is not now used in baking in the United Kingdom and there seems no likelihood that it will be used. There does not appear to be a permanent or an expanding market for papain in any of these uses and demand is likely to remain insignificant.

2.5. THE PHARMACEUTICAL INDUSTRY

Very many pharmaceutical and medical uses have been attributed to papain. A list of those emerging from various sources[3 4 78 79] is given in Table 1. Many of them seem to be concerned with external treatment of hard tissues on the skin, for example, wart removal, treatment of scar tissues on wounds, acne treatment, depilation or skin cleansing creams. The internal uses are connected with the treatment of diphtheria, dispepsia, croup in cattle, gastric insufficiency and other veterinary uses such as de-worming (anthelminthic) for dogs.

There is little hard evidence that any of these external or internal uses have ever been more than research studies in the laboratories of the larger pharmaceutical firms and in this research context no more than a few kilos per firm per year are being used. No significant commercial applications have been identified and fashion more than efficiency (for example in skin cleansing creams) will influence potential utilisation except in the case of veterinary preparations.

Two of the more dramatic applications recently given notice were: (1) plastic surgery on cleft palates in South Africa[80] and (2) the treatment of prolapsed spinal discs in the United States by the injection of chymopapain.[81] Both of these are still at the experimental stage and the latter has not yet been approved by the United States Food and Drug Administration

for widespread application. These uses may become medically significant and widely applied, but once again the quantities of papain involved are likely to be small and the quality required extremely high.

The largest use of papain in the pharmaceutical industry seems to be in the preparation of vaccines. This involves growing bacteria in order to isolate specific components for production of the actual vaccine. The papain is employed in the preparation of peptone broths from meats to break down and release proteins for more rapid consumption by the bacteria.

The quantities of papain involved are only of the order of magnitude of about one kilo per day or some 200–300 kilos per year by the average firm using papain and up to 500 kilos per year by the larger firms. The number of firms in total producing vaccines is small. There is some small potential for increased use of papain in this field. The demand for vaccines tends to be a function of the outbreak of epidemics or the threat of these arising out of floods, famines and other major disasters.

2.6. LEATHER BATING

Papain has long been used in small tanneries in West and East Africa and elsewhere for leather bating. In parts of Africa the use is reported of a type of melon known as tanners' melon which may be confused with the paw-paw from which papain is extracted.

The results obtained by using papain alone are of low standard and long experience in papain use is necessary before uniformly acceptable results are achieved. Part of the difficulty lies in the irregularity of enzyme activity available at this level of operation from local sources. Under the conditions employed in leather bating papain may not be active in the desired way. Nowadays better and more reliable bating preparations are available almost everywhere and because high standards in the production of leather are now demanded in affluent countries especially, then small tanneries in developing countries will of necessity have to use the better bating materials for more uniform and more reliable products.

Bating materials are aimed at achieving greater mobility and softness in hides and skins.[82] They do this by breaking down the collagen between connecting fibres (inter-fibrillary proteins) and they must be specific to this task, otherwise they would destroy the basic structure of the hide or skin. The fundamental difficulty about papain in this respect is that not enough is known about its specificity in dealing with this problem. Much more is known about other bating materials based on animal proteases, principally trypsin, and on fungal and bacterial enzymes.

Papain plays additional roles in the bating material:

(1) as an unhairing agent and

(2) as an ancillary to using caustic soda instead of lime, which can give rise to problems in subsequent leather dying and other processes.

The first of these uses is the more important.

Papain is sometimes added to trypsin, fungal and bacterial preparations for special purposes, especially where extra softness is required, for example in producing extra soft calf leathers for special orders or uses. The quantities of papain used are small, perhaps 100 kg per year by the average bate manufacturing company using papain, and exceptionally up to 500 kg by the larger companies. The dosage for bating is about 0·5–2 % of the wet-drained weight of the hide or skin. Sheepskins weigh roughly 1–2·5 kg (2–5 lb), cattle hides 5–7 kg (10–15 lb) and buffalo hides 10–20 kg (20–40 lb). If one considers that about 85 % of a bating preparation is

made up of a bulking substance such as wood flour, and only about 5% is enzyme, then the papain proportion of the enzyme used is very small indeed. The potential for any increased use of papain is virtually eliminated when costs are compared: £3 per kilo for papain as against £0·10–£0·15 per kilo for other enzymes.

Bating materials are readily available in most developing countries and there are many American, European and Japanese companies competing for sales.

One company alone listed the following countries to which it exports bating preparations: Portugal, Spain, Italy, Greece, Iran, Egypt, Morocco, South Africa, Central African countries, India, Pakistan, Indonesia, Hong Kong, Taiwan, Colombia, Peru, Uruguay, Chile, Venezuela and Mexico. Countries such as Argentina with a huge cattle industry are largely self-sufficient. Countries with a substantial cattle industry and a tanning industry but with poor access to papain sources might find it more to their advantage to develop their pancreatic sources of bating materials as a useful by-product enterprise and an exercise in import substitution.

The normal procedure for exporting manufacturers is to contract with local companies, agents or large tanneries in developing countries. Bating preparations are often sent out to these in either

(a) bulk form for re-packing into smaller lots for distribution to small tanneries or

(b) concentrated form for re-grading on arrival by the recipient for his own use or for distribution.

Sometimes malpractices creep in, such as holding materials too long in storage with resultant loss in enzyme activity, or dilution below the recommended enzyme strength.

Chapter 3

World trade in papain

3.1. EXPORTS

3.1.1. The present pattern of production

The principal sources of crude papain at the present time are: Zaire, Tanzania, Uganda and Sri Lanka. Quantities, values and destinations are given in Tables 7–11. Other sources of small quantities of crude papain are: Kenya, the Caribbean, Israel, the Philippines, India and Cameroon.

The chief source of the higher qualities (see Chapter 1) of flake papain and soluble, sterile, spray-dried papain is Zaire. Small quantities have come in recent years from Taiwan, Ecuador and Tanzania: samples of these papains which have been received by the trade have been commended for their high standards and might be preferred if standards of crude papain continue to deteriorate.

Countries which have at recurring intervals shown an interest in the production of papain and which have produced both crude and sterile papains either with a view to entering world trade or for domestic purposes are: Argentina, Bolivia, Colombia, Paraguay, Peru, Dominica, the United States, the Gambia, Ghana, South Africa, Malaysia, Samoa, Sarawak, Thailand, China, Australia and New Zealand. New entrants would be welcomed by the trade if they were able to overcome the technical and economic difficulties in production and guarantee reliable deliveries of consistently high quality papain.

3.1.2. The changing pattern of production

The main features in a pattern of production which has been changing in recent years have been the decline of Sri Lanka as a major exporter resulting from the outbreak of mosaic disease,[3] followed by the decline of Uganda resulting from the expulsion of the Asian population, and parallel with these the development of the industry in Zaire. Following the collapse of marketing channels from Uganda and the efforts of two companies[6,83] in Zaire to develop the industry there, Zaire has now become the principal producer of papain in terms of crude papain equivalent. One of these companies[6] was by mid-1973 claiming to produce 59% of the world's crude papain equivalent. This percentage may well increase. In view of the increasing demand for consistently reliable, high-quality papain other producers delivering lower grades of crude white and brown papains may find it difficult or even impossible to compete with the Zaire producers.

3.2. IMPORTS

The principal importing countries are: the United States, Japan, the United Kingdom, Belgium and France. Quantities, values and origins are given in

Tables 12–15. Many other countries import small quantities, principally for research purposes. These include: West Germany, Denmark, Norway, Sweden, Italy, Ireland, Spain, Portugal, Poland and Czechoslovakia. Official statistics are not available for these very small quantities.

Almost all of the best quality papain finds its way eventually to the United States, where it is refined and formulated into papain preparations which also include other additives such as stabilisers. These formulations are used domestically in the United States or re-exported all over the world. It is estimated for example that more than 50% of the papain used in beer chill-proofing in the United Kingdom is imported from the United States, as formulations prepared from papain originally imported into the United Kingdom and re-exported to the United States. This percentage could decline, however, if enzyme houses in the United Kingdom increase their purchases of spray-dried papain which is gaining favour with some brewers (see Chapter 2), who say it might be even more popular if made available as a liquid solution.

Papain preparations for beer chillproofing, meat tenderisation, and leather bating find their way (mostly from the United States and to a lesser degree from the United Kingdom) to nearly all countries where beer is chillproofed, certainly to all countries where meat is enzyme tenderised, and to many countries which have leather tanning industries.

3.3. Quality of papain

The various quality grades of papain are outlined in Chapter 1 and the unit measurement of enzyme activity is described in Chapter 4.

The deterioration in quality of crude papain has given cause for concern amongst end-users. The former No 1 White with an enzyme activity reliably in the region of 500 units has become increasingly rare and some suppliers are now said to be offering for sale as No 1 White grade papains which were formerly classified as No 2 grade and which have enzyme activities around 300 units. More usually nowadays the old distinction of No 1 White and No 2 Brown no longer applies and according to some importers the variations in quality are greater than ever before and successive consignments have widely differing levels of enzyme activity. It is an understatement to say that inconsistencies such as these are not welcomed and lead to a complete lack of confidence in suppliers and consequently lower price offers.

In nearly all cases importers have been disappointed with the quality of crude papain in recent years and most importers would welcome new sources of supply provided the quality, the price and the reliability of supply were acceptable. Many would welcome contracts, but those who have tried them in the past have been disappointed by the failure of producers to fulfil contracts, and as yet there is no means of arbitration on matters such as breach of contract or quality standards.

The principal origins of poor quality papain are:

(1) faulty tapping and collecting

(2) faulty drying

(3) incorrect storage and packing, and

(4) the activities of some middlemen.

The best tapping and collecting procedures are described elsewhere,[79 84 85] but it is noteworthy that poor tapping and collecting still prevail despite the wide availability of information on the best techniques. The critical areas are: firstly, tapping by incisions which are too deep and allow juices and starch

from the fruit pulp to contaminate the latex; secondly, tapping at times other than in the morning or on overcast days which results in quality reduction of the latex; thirdly, tapping too soon before maturity or too long after maturity; fourthly, collection of the coagulated latex clinging to the fruit. All of these should be avoided, as should also the practice of leaving latex for too long in the sun, where it can lose enzyme activity and collect foreign matter such as insects and dust. Other aspects[79] such as variety, size of fruit, position of fruit on the tree, age of tree, all make a contribution.

In drying the main cause for concern is the lack of drying equipment, especially in heavy rainfall areas. Sun-drying leads to browning of the papain and to considerable loss of enzyme activity, an important conservation aspect. The provision of oven-drying facilities, perhaps on a co-operative basis, would lead to an improvement in quality.

Another important factor affecting the quality of papain is storage in poor environments by some middlemen, which leads to deterioration of enzyme activity.

3.4. PACKAGING

There is still some dissatisfaction with packing of crude papain. The old method of packing in paraffin or petrol tins and sealing by soldering the lid on still prevails in some areas. With this method pieces of the lead solder often fall into the papain. To avoid this a British firm[86] years ago recommended that the papain be put into plastic bags and tied before sealing in the tins and this practice was widely adopted. A recommendation by German and American firms that papain be placed in plastic bags and the air displaced by inert gas before sealing in the tins[3] never received much support. Although it is the best method it is expensive and presupposes that nitrogen or other cylinder gas is available. Vacuum packing would be equally acceptable, but is also expensive.

The method most commonly used today is packing in plastic bags which are tied and put into hessian or jute sacks which are then tied. There are, however, abuses even in this method. Sometimes the plastic bags are left untied or inadequately tied before being put into the outer sack, or re-opened and left open by customs officers. Frequently, too, the hessian or jute sacks are second-hand and still bearing the markings of other commodities such as tea, coffee or cocoa. This, in the words of one reputable importer, is not good enough for a product selling at up to £2 per lb.

Another criticism levelled at middlemen is that they mix various types of papain to make up a consignment and in addition they have a bad habit of supplying in catch weights or in weights of any quantity.

The better practices of:

(1) packing in agreed standard weights (perhaps 50 kg)

(2) use of new rather than second-hand sacks

(3) clear markings of content, grade and origin, and

(4) proper sealing of plastic bags

would help greatly to get the trade on a better footing and would undoubtedly promote the interests especially of small farmers, who will continue to supply crude papain, and who have neither the capital equipment for the production of refined papain nor a fraction of the production required to make it worth while.

3.5. THE PAPAIN CYCLE

Exports of papain (Table 6) have varied over the last 25 years between roughly 100 and 400 metric tons. The pattern exhibits cyclical behaviour, rising to the higher figure or above and falling to the lower figure, a full cycle taking about five years. Prices behave similarly. Both quantity and value series have been fitted with cyclic curves (by Fourier analysis) in Figures 5 and 6, and it can then be observed that superimposed upon the cyclical patterns there is also a tendency overall for both quantity and values to rise slowly over time.

The cyclical behaviour is said to be a function of yield of tree changing with age. Yield, it is said, increases up to two or three years and then decreases. One source,[79] however, gives evidence from various countries which seems to indicate that the cycle (from the point of view of tree behaviour) is not very pronounced, is not constant, and varies from country to country. Yield may in fact be deduced as fairly constant, but production may decline as the tree grows taller.

The cyclical variation has been explained on the hypothesis that when prices are high there is a stimulus to the planting of paw-paw trees which will be in full production after about two years and remain so for about three years. This pattern gives rise to over-production and low prices it is claimed, and trees are then uprooted in favour of other crops. Low production then occurs and prices rise again so that the cycle starts again after about five years. This hypothesis, however, does not take into account the above evidence by Lassoudiere[79] now available, the time lag in farmers' response to price changes and the behaviour of some middlemen who have been able to take advantage of the cycle.

3.6. PRICES

Tables 16 and 17 give respectively average prices from 1962 to 1970:

(a) for white papain fob Colombo and

(b) for East African No 1 papain cif United Kingdom.

Table 18 presents quantities and values for imports into the United States and Japan from 1950 to 1971. These are then graphed in Figures 1 to 4, illustrating the well-known 'papain cycle' of prices rising and falling as supplies decrease and increase. Table 19 gives quantity and value data for imports into the United States from 1947 to 1971 with projections to 1976. Curves are then fitted to these data in Figures 5 and 6 as described in the previous section.

Because of developments in the supply industry (as outlined above) as well as inflation and international currency difficulties, price levels since 1971 have not conformed to the familiar cycle pattern and currently prices tend to be paid according to the quality of particular lots of papain. Crude brown No 2 grade papain fetches roughly £2·25 to £3·25 per kg (£1–£1·50 per lb) and crude white No 1 grade from £3·25 to £5·00 per kg (£1·50–£2·25 per lb). Prices for the flake and powder papains are less well known since these are handled by companies marketing direct to the end-user. Samples of sterile, spray-dried papain powder are known to have been offered at more than twice the price of crude white No 1, but they can of course often be used directly by the end-user without further processing or refining.

There seems to be very little need for prices to fluctuate. The history of the trade, illustrated in Figures 5 and 6, indicates a stable market on the demand side with a slight overall upward trend. This stability of demand is confirmed by many contacts with the trade and industry users. Only the

occasional importing agent maintains that papain usage will decline, while the analysis in Chapter 2 would indicate that demand will increase more perceptibly than formerly. Industry users in general prefer stable prices for forward planning. That this is possible in combination with reliability of supply and quality is indicated by the two Belgium companies operating in Zaire.

Crop planning should help to stabilise prices and supply and this might be facilitated by the establishment of national marketing structures. Marketing boards might reasonably be expected to communicate price changes to small farmers, to overcome lags in farmers' supply response to prices and to maintain quality standards. These measures, together with implementation of the recommendations on packaging outlined above, would help to guarantee a stable cash income for small farmers and customer satisfaction.

Chapter 4

The measurement of enzyme activity

(by J. C. Caygill)

The effectiveness or potency of an enzyme is most usefully expressed in terms of its 'activity', which is a measure of its power as a catalyst. When possible this is expressed in units of activity which are defined in terms of the weight of substrate (reactant) transformed or product produced in a given time. Thus one unit of activity would be the amount of enzyme catalysing the hydrolysis (in the case of a hydrolytic enzyme like papain) of one mole of substrate in one minute, and in the case of a pure enzyme this would be expressed as units per mg dry weight. The rate of enzyme catalysed reactions is affected by the temperature and pH (acidity) of the solution in which they are measured. Therefore to have any meaning these must be stated. The activity must be given, for example as units/mg at 30°C and pH 5·0. Unfortunately it is too common to forget to state the conditions, making the activity value useless for comparative purposes.

In the case of an enzyme such as papain which attacks a particular type of bond (the peptide bond) in a number of proteins the activity will vary with the protein used as substrate and the figure must therefore also state the substrate very exactly (for example by giving the supplier and the grade of casein used in the assay).

There are three common types of assay used to measure the activity of papain. The first is a group of methods based on the hydrolysis of low molecular weight synthetic substrates. These methods are the most exact, most expensive and least relevant to practical application. The second group of methods is based on the rate of hydrolysis of proteins. There are many methods of measuring this rate, methods which are reliable provided the nature and source of the protein is given (as above) and provided the method of measuring the extent of hydrolysis is given as it usually is. However, with so many combinations of protein and methodology to choose from it is rare for two laboratories to use the same method, and therefore comparison between the results from different laboratories is impossible.

One of the simplest methods of following the hydrolysis of proteins is to measure the amount of tyrosine (an amino acid component of proteins) released from the protein. This can be expressed as moles of tyrosine released per minute which corresponds to the definition of enzyme activity given above. The results are therefore expressed as tyrosine units/mg.

It may be worth noting that the tyrosine is linked into a chain of amino acids by two bonds. The method of analysis would detect free tyrosine (two bonds split) or tyrosine linked to a few amino acids in an oligopeptide. In other words, if there was a sequence in the protein as follows:

```
   1    2    3    4    5      6     7     8     9
   ↓    ↓    ↓    ↓    ↓      ↓     ↓     ↓     ↓
A —— B —— C —— D —— E —— tyr —— F —— G —— H —— J
```

and papain split either bonds 5 or 6 or bonds 4 and 7 the activity would be expressed as 1 tyrosine unit in both cases. If it also split bonds 1, 2, 3, 8, and 9 (9 in all, not 2), the method would only detect the release of the tyrosine, so a value of only 1 tyrosine unit would again be reported. This underlines the importance of stating the precise conditions under which the assay is carried out and illustrates why only results carried out under precisely defined conditions can be used to draw comparisons, even though both procedures are ostensibly giving results as 'tyrosine units'.

The third group of assay methods is based on milk-clotting ability. Although it is not possible to give any exact definition of milk-clotting units, these methods are the cheapest in terms of materials, but not in time taken. There are many restrictions on what can be done in this assay without nullifying the result, but it is not always clear whether the restrictions have been respected. The most important and most commonly overlooked restriction is that every single batch of milk, whether reconstituted, skimmed dried or fresh, gives different results, and it is necessary to measure the clotting power of a standard reference papain to calibrate the batch of milk and then to express the activity relative to this standardised papain. Unfortunately this is rarely done, and thus comparison of the results between different laboratories is often meaningless and small variations in the reported results from any one laboratory are of dubious significance. As a rough guide, when the most commonly used procedure is adopted one laboratory may report results of 450 and (at a later date) 420 units for two batches of papain of equal milk-clotting power, whilst another laboratory might report an activity of 500 units for the second sample.

Thus when activity is expressed in milk-clotting units without further qualification these should be regarded as qualitative guides to activity or as indications of good or bad quality. Only when two samples are compared in the same laboratory with the same reagents (milk or other) can small differences in activity be reliably detected.

In interpreting measurements of papain activity, two other factors should be remembered. The rate of hydrolysis and final degree of hydrolysis of different proteins by a papain sample may differ. The activity measured in milk clotting units or as tyrosine release may not be the same as the activity required by the user, who may wish to digest beer, meat or other proteins. In part, this arises because crude papain is a mixture of several proteases, and only one may be required or be suitable for a specific application. This is conveniently illustrated by the purification of chymopapain from crude papain for use in prolapsed disc therapy. Here the user is interested in the activity of chymopapain on the chondromucoprotein of the intervertebral disc, not that of crude papain on milk.

Despite these reservations on the interpretation of measurements of papain activity, it is appropriate to conclude by stressing that the producer should make every effort to maintain the activity of his product. The Tropical Products Institute is willing to send to producers instructions for low-cost assay procedures. The value of papain is related to its activity. A producer, able to measure the activity at the site of production, is able to monitor the efficacy of his drying and storage conditions and can test local improvisations to produce the better product which the market seeks.

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Appendix A

Addresses of importers, processors, industrial users and statistical sources

1. Papain importers

Biddle Sawyer and Co Ltd
Import-Export Merchants
Plantation House
Mincing Lane
London EC3
UK

Hughes and Hughes Ltd
Elms Industrial Estate
Church Road
Harold Wood
Romford
Essex RM3 0HR
UK

Chas Zimmermann and Co Ltd
Dawson Road.
Bletchley
Milton Keynes MK1 1JR
UK

O Kees Ltd
P.O. Box 451
Brentwood
Essex
UK

Sempa-Chimie
B.P. 338
58 Rue du Dessous-des-Berges
Paris 13
France

Ets Schmitt-Jourdan
22 Rue de la Tourelle
92,100 Boulogne-Billancourt
France

Enzymase Belgium SPRL
Avenue d'Italie 45
B-1050 Brussels
Belgium

Compagnie Commercial Kreglinger
Grote markt 9
2000 Antwerp
Belgium

NV Chemische Fabriek Naarden
P.O. Box 2
Naarden-Bussum
Holland

Enzyme Development Corporation
2 Penn Plaza
New York 10001
NY
USA

J E Siebel Sons Company
Miles Laboratories Inc
Marschall Division
4055 West Peterson Avenue
Chicago 60646
Illinois
USA

Wallerstein Company
Division of Travenol Laboratories Inc
Deerfield
Illinois
USA

Pfizer Chemicals
Grand Avenue
Parramatta
New South Wales 2150
Australia

Halcyon Proteins Pty Ltd
40 Miller Street
North Sydney
New South Wales 2060
Australia

Lindgren Holdings Pty Ltd
901 Lytton Road
Murarrie
Queensland 4172
Australia

Griffith Laboratories Pty Ltd
10 Ramage Street
Bayswater
Victoria 3153
Australia

2. Papain buyers and processors

Murphy and Son
Consulting and Manufacturing
Chemists
Wheathampstead
St Albans
Herts
UK

ABM Industrial Products Ltd
Wordley
Stockport
Cheshire
UK

Powell and Scholefield Ltd
38 Queensland Street
Liverpool L7 3JG
UK

3. The beer industry

EFTA Brewing Industry Council
EBIC
Zaunergasse 3
1030 Vienna
Austria

European Brewery Convention (EBC)
P.O. Box 455
Rotterdam
The Netherlands

Communaute de Travail des
Brasseurs du Marche Commun
(CBMC)
B1160 Brussels
207 Boulevard du Souverain
Belgium

The Brewers' Society
42 Portman Square
London W1H 0BB
UK

The Brewing Industry Research
Foundation (BIRF)
Nutfield
Surrey
UK

Institute of Brewing
33 Clarges Street
London W1
UK

United States Brewers Association
Inc
1750 K Street
North West Washington DC 20006
USA

The Kirin Brewery Co Ltd
Planning and Research Department
Kyo-Bashi
Tokyo
Japan

The Breweries Association of Japan
No 1
2-Chome Kyo-Bashi
Chuoku
Tokyo
Japan

Unione Italiana Fabbricanti Birra e
Malto
Via Savoia 29
20198 Rome
Italy

The Secretary
Australian Brewers Association
16 Bouverie Street
Carlton
Victoria 3053
Australia

Dr R N Greenshields, Consultant
Department of Biological Scientists
University of Aston
Gosta Green
Birmingham B4 7ET
UK

Watney Mann Brewery
Mortlake
London SW14
UK

Truman's Brewery
91 Brick Lane
London EC1
UK

Bass Charrington
High Street
Burton-on-Trent
Derbyshire
UK

Allied Breweries
Station Road
Burton-on-Trent
Derbyshire
UK

Whitbread and Co Ltd
Chiswell Street
London EC1
UK

4. The meat industry

The Meat Research Institute
Agricultural Research Council
Langford
Bristol BS18 7DY
UK

The Meat and Livestock Commission
P.O. Box 44
Queensway House
Bletchley
Milton Keynes
UK

The British Food Manufacturing
Industry Research Association
(BFMIRA)
Randalls Road
Leatherhead
Surrey
UK

CSIRO Division of Food
Research
Meat Research Laboratory
P.O. Box 12
Cannon Hill
Queensland 4170
Australia

The American Meat Institute
939 East 57th Street
Chicago 5
Illinois
USA

The Australian Meat Board
P.O. Box 4129
30 Grosvenor Street
Sydney
New South Wales
Australia

The Meat Industry Research
Institute of New Zealand (Inc)
P.O. Box 617
Hamilton
New Zealand

Swift and Co
1919 Swift Drive
Oak Brook 60521
Illinois
USA

Swift and Co Ltd
10 Charterhouse Square
London EC1
UK

5. The pharmaceutical industry

Evans Biologicals Ltd
Penn Lane
Runcorn
Cheshire
UK

Wellcome Research Laboratories
Langley Court
South Eden Park Road
Beckenham
Kent
UK

Polskie Odczynniki Chemiczne
Export-Import of Laboratory
Chemicals
Gliwice
ul Sowinskiego 11
Poland

6. Leather bating

Hexoran Co Ltd
Unity Works
Derwent Street
Belper
Derby DE5 1WQ
UK

Pancreol Ltd
Ripponden
Sowerby Bridge
Yorks HX6 4DW
UK

7. Statistics and markets

Officer-in-Charge
Market Development Advisory Service
International Trade Centre
Palais des Nations
CH-1211 Geneva 10
Switzerland

Institute Centrale di Statistica
Via Cesare Balbo 16
Rome
Italy

Chief
Commodity and Products Analysis Branch
Sugar and Tropical Products Division
USDA Foreign Agricultural Service
Washington DC 20250
USA

Tropical Products Institute
56/62 Gray's Inn Road
London
UK

Appendix B

Statistical tables and figures

Table 1

Papain uses and alternative enzymes

Row	Uses a	Preferred Enzyme b	Alternative Enzymes c
	Food and beverages		
1	Beer chillproofing	Papain	Bromelain, Ficin
2	Meat tenderisation	Papain	Bromelain, Ficin
3	Fish protein extraction		Bacterial and fungal proteases
4	Cheese making		Bromelain, Ficin
5	Cheese re-working		Bromelain, Ficin
6	Non-clotting margarine	Rennin	
7	Dietary and baby foods	Pepsin	
8	Baking and confectionery		
9	Animal feed		
	Pharmaceuticals		
10	Vaccine preparation	Papain	
11	External applications (acne, wound scars, warts, depilation cream, plastic surgery on cleft palate, toothpaste)	Papain	
12	Internal applications (croup in cattle, dyspepsia, diphtheria, animal de-worming, injection for prolapsed disc, gastric insufficiency).	Pepsin, Trypsin, Chymopapain	Bromelain, Ficin, Papain
	Miscellaneous uses		
13	Leather bating	Trypsin	Papain, Calotropain,
14	Textiles & laundering (wool softening, stain removal, silk de-gumming)	Bacterial proteases	Bromelain, Ficin
15	Paper		
16	Adhesives		
17	Photography		
18	Water based paints		
19	Plastics		
20	Rubber moulding		

Source: See Chapter 2.

Table 2

World beer consumption, 1972

Row	Country a	Imperial Gallons Total '000 b	Per cap. c	Hectolitres Total '000 d	Litres Per cap. e
1	West Germany	1 976 634	32·0	89 847	145·3
2	Czechoslovakia (d)	423 000 (b)	30·8	19 227 (b)	139·9
3	Belgium	285 714	29·5	12 987	134·0
4	Australia	366 144	28·2	16 643	128·2
5	New Zealand (e)	76 415	26·7	3 473	121·4
6	Denmark	132 572	26·6	6 026	121·0
7	Luxembourg	9 240	26·4	420	120·0
8	Ireland	75 240	25·3	3 420	115·0
9	United Kingdom	1 319 560	23·7	59 980	107·5
10	East Germany	399 410	23·4	18 155	106·5
11	Austria	170 038	22·8	7 729	103·7
12	Canada (e)	365 192	16·8	16 600	76·5
13	Switzerland	102 036	16·5	4 638	75·0
14	USA (e)	3 264 095	15·8	148 368	71·8
15	Netherlands	192 896	14·5	8 768	65·9
16	Sweden	99 440	12·2	4 520	55·6
17	Finland	55 264	12·1	2 512	55·0
18	Norway	35 486	9·0	1 613	41·0
19	France	435 952	8·9	19 816	40·3
20	Spain	265 518	7·8	12 069	35·5
21	Poland	256 938	7·8	11 679	35·3
22	Colombia (e)	162 250	7·4	7 375	33·8
23	Japan	746 900	7·0	33 950	31·6
24	Yugoslavia (d)	143 000	6·8	6 500	31·1
25	Mexico	322 784	5·9	14 672	27·0
26	Peru (a)	68 200	5·0	3 100	22·9
27	Chile (e)	47 476	4·9	2 158	22·3
28	Republic of Zaire	94 666	4·0	4 303	18·2
29	USSR (e) (c)	970 200	4·0	44 100	18·2
30	Trinidad and Tobago	4 051	3·9	184	17·7
31	Cyprus	2 477	3·8,	113	17·3
32	Italy	150 898	2·6	6 859	12·0
33	Brazil (c)	213 906	2·3	9 723	10·4
34	Philippines	68 992	1·8	3 136	8·0
35	Ghana (e)	9 108	1·0	414	4·6
36	Sierra Leone (e)	1 408	0·6	64	2·5
37	Nigeria (e)	30 910	0·5	1 405	2·1
38	Turkey	10 494	0·3	477	1·5
39	Estimated figures for other countries beer consumption	1 495 496		67 977	
40	Estimate for 1972 world beer consumption based on latest U.N. production figures	14 850 000		675 000	

Source: Brewers' Society.

Footnotes: (a) 1970 Population figures; (b) Estimate; (c) Production data; (d) 1970 data; (e) 1971 data.

Conversion ratio: 22 Gallons = 1 Hectolitre.

Table 3

World beer production, 1972

Row	Country a	Imperial Gallons ('000) b	Hectolitres ('000) c
1	West Germany	2 003 298	91 059
2	Czechoslovakia	494 956	22 498
3	Belgium	296 890	13 495
4	Australia	372 997	16 954
5	Denmark	187 000	8 500
6	Luxembourg	13 684	622
7	Ireland	119 880	5 449
8	United Kingdom	1 269 862	57 721
9	East Germany	405 790	18 445
10	Austria	178 046	8 093
11	Canada (b)	376 578	17 117
12	Switzerland	99 594	4 527
13	USA.	3 648 920	165 860
14	Netherlands	217 250	9 875
15	Sweden	93 610	4 255
16	Finland	55 638	2 529
17	Norway	37 752	1 716
18	France	460 372	20 926
19	Spain	319 000	14 500
20	Poland	259 820	11 810
21	Colombia (b)	162 250	7 375
22	Japan	751 520	34 160
23	Yugoslavia (a)	143 000	6 500
24	Mexico	328 724	14 942
25	Chile	58 168	2 644
26	Republic of Zaire	93 742	4 261
27	USSR (b)	970 200	44 100
28	Trinidad and Tobago	4 011	183
29	Cyprus	2 724	124
30	Italy	144 100	6 550
31	Brazil	213 906	9 723
32	Philippines	70 334	3 197
33	Ghana (b)	9 218	419
34	Sierra Leone (b)	1 342	61
35	Nigeria (b)	31 042	1 411
36	Turkey	11 814	537
37	South Africa	73 260	3 330
38	Production for other countries	869 708	39 532
39	World Total (Estimate based on U.N. statistics)	14 850 000	675 000

Source: Brewers' Society.

Footnotes: (a) 1970 data (b) 1971 data

Conversion ratio: 22 Gallons = 1 Hectolitre.

Table 4

Changes in beer consumption in the United Kingdom, 1960–72

Row	Type of beer a	per cent 1960 b	1972 c
1	Draught, mild	39	18
2	Draught, bitter	23	27
3	Bottled, pale and light	13	12
4	Bottled, brown	11	5
5	Stout, bottled and keg	10	10
6	Lager, bottled and keg	2	9
7	Keg ales, bitter	2	19

Source: Brewers' Society.

Table 5

Estimated meat consumption (lb/head) in certain countries, 1970

Row	Country a	Beef & Veal b	Mutton & Lamb c	Pig Meat d	Poultry Meat e	Offals f
	Commonwealth:					
1	Australia	86[1]	83[1]	25[1]	23·3[1]	11·5[1]
2	New Zealand	104[2]	89[2]	30[2]	—	11·4[2]
3	Canada	90	4	57	44·8[6]	3·4
4	United Kingdom	47	21	49	23·6[6]	7·7[7]
	Foreign:					
5	USA	117	3	66	49·6[5,6]	10·9
6	Argentina	185	13	19	—	—
7	Irish Republic	42	24	68	22·0	28·4
8	Denmark	44	—	65	10·8[6]	14·7
9	Sweden	—	—	59	—	—
10	Belgium	56	—	58	18·9	—
11	France	66	7	60	32·3	—
12	Switzerland	—	—	—	15·0	—
13	Italy	54	2	23	25·7	—
14	West Germany	53	—	85	18·5	10·4
15	Netherlands	43	—	58	13·0	—
16	South Africa	56[1,3]	22[1,4]	8	—	—
17	Japan	6	2	14	—	—
18	Uruguay	130	—	—	—	—
19	Venezuela	45	—	—	—	—
20	Yugoslavia	—	—	30	15·2	—
21	Czechoslovakia	—	—	—	18·1	—
22	East Germany	—	—	—	11·7	—

Source: Commonwealth Secretariat, 1973, 'Meat, a review'.

Footnotes:
1 Twelve months ending 30th June of year stated
2 Twelve months ending 30th September of year stated
3 Including offals
4 Including goat meat and offals
5 Fowls and turkeys only
6 Ready-to-cook weight
7 Revised series.

Table 6

Papain exports from producing countries (tonnes)

Year	Sri Lanka (Ceylon)	Zaire	Kenya	Uganda	Tanzania	Total	Value pence/kg
1950	68·5	10·6	0·8	24·4	19·9	124·2	136
1951	69·5	14·4	0·3	10·6	18·8	113·6	338
1952	98·4	14·3	0·2	12·2	44·2	169·3	360
1953	179·6	24·0	1·1	22·4	85·0	312·1	306
1954	222·6	44·9	1·4	31·1	104·2	404·2	141
1955	116·8	41·8	0·2	23·9	38·1	220·8	132
1956	84·5	50·7	0·1	10·0	17·8	163·1	192
1957	114·6	58·7	0·2	3·8	23·7	201·0	236
1958	72·7	97·6	0·3	7·0	69·4	247·0	239
1959	138·3	152·7	—	10·6	76·3	377·9	142
1960	108·8	199·1	—	4·9	73·1	385·9	112
1961	34·7	1·5[a]	—	2·9	72·8	111·9	150
1962	31·2	65·2	—	7·2	52·5	156·1	188
1963	51·2	32·2	0·5	56·6	91·3	231·8	227
1964	82·4	56·8	—	193·3	65·2	397·7	210
1965	68·2	83·2	0·5	177·4	51·5	380·8	188
1966	45·1	55·0	—	115·3	35·7	251·1	154
1967	19·3	(51·2)	—	178·8	41·1	290·4	177
1968	19·9	78·3	—	173·5	27·9	299·6	225
1969	24·9	(60·9)	—	226·5	29·4	341·7	179
1970	(14·5)	(70·4)	—	117·4	40·5	242·8	140
1971	(4·9)	(45·3)	—	111·9	36·2	198·3	158

Sources: Mainly official export statistics of the countries shown. Figures in brackets derived from imports into United States and Japan, attributed to Ceylon and Zaire.

Footnote: a: Probably under-recorded. United States imports show 62 tonnes attributed to Zaire in 1961.

Table 7

Papain exports from the Zaire Republic

		1962	1963	1964	1965	1966	1967	1968	1969	1970
Total	tonnes	65·2	32·2	56·8	83·2	55·0	..	78·3	174·0	59·1
	£'000	115·1	57·8	116·1	197·1	134·3	..	107·2	189·6	65·2
of which to:										
Belgium & Luxembourg	tonnes	—	—	38·3	80·2	..	..	77·6	164·5	51·6
	£'000	—	—	93·9	189·9	..	..	106·3	179·2	56·9
France	tonnes	—	—	—	—	..	..	0·7	—	1·3
	£'000	—	—	—	—	..	..	0·9	—	1·4
German Federal Republic	tonnes	20·3	24·9	—	0·1	..	..	—	5·0	—
	£'000	46·9	46·3	—	0·2	..	..	—	5·5	—
USA	tonnes	—	—	—	0·1	..	..	—	3·0	—
	£'000	—	—	—	0·2	..	..	—	3·3	—
Kenya & Uganda	tonnes	41·6	7·3	17·9	—	..	..	—	—	1·0*
	£'000	62·9	11·5	20·8	—	..	..	—	—	1·1
Other countries	tonnes	3·3	—	0·6	2·8	..	..	—	1·5	5·2
	£'000	5·3	—	1·4	6·8	..	..	—	1·6	5·7

Sources: 1962–1965 Commerce Exterieur;
Direction de la Statistique et des Etudes Economiques.
1966 Total Bulletin Trimestial;
Statistique Générales de la République Democratique du Congo.
1968–1970 Annuaire des Statistiques du Commerce Extérieur;
Office National de la Recherche et du Développement.

Footnotes: —Nil or negligible;
..Not available;
*Uganda only.

Table 8

Crude papain exports from Uganda

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Total	tonnes	7·2	56·6	193·3	177·4	115·3	178·8	173·5	226·5	117·4	111·9	175·1
	£'000	16·0	113·6	356·3	262·7	123·3	301·4	448·6	376·8	129·0	147·0	310·2
of which to:												
Belgium & Luxembourg	tonnes	—	0·3	—	4·2	37·2	49·3	76·3	108·7	26·6	25·5	14·2
	£'000	—	0·5	—	8·3	48·0	122·3	192·8	159·8	23·3	29·6	20·7
France	tonnes	0·4	3·0	2·9	4·7	2·8	0·3	3·5	3·1	—	—	2·8
	£'000	0·4	9·7	6·0	8·5	2·6	0·3	7·7	3·7	—	—	5·0
German Federal Republic	tonnes	—	1·0	0·5	2·1	1·7	5·6	5·3	17·8	—	8·7	13·1
	£'000	—	1·9	1·5	2·9	1·2	9·6	12·4	29·6	—	15·6	17·5
Italy	tonnes	—	—	0·3	—	1·0	0·4	—	—	1·5	2·5	1·3
	£'000	—	—	0·7	—	0·9	0·2	—	—	2·0	4·2	2·9
Netherlands	tonnes	—	0·2	0·3	1·6	—	3·6	—	22·4	15·0	17·3	19·9
	£'000	—	0·4	0·4	1·8	—	5·0	—	34·9	18·3	17·5	20·2
UK	tonnes	2·4	9·9	11·3	19·0	12·4	10·2	13·8	20·7	16·8	16·1	17·4
	£'000	6·8	30·7	28·8	36·6	11·8	15·5	30·3	28·7	17·6	17·3	24·8
Japan	tonnes	—	7·1	13·0	6·2	13·8	14·6	22·9	15·9	32·8	22·0	68·2
	£'000	—	17·7	26·0	12·1	12·3	16·8	44·0	23·7	32·8	29·6	138·3
Argentina	tonnes	—	—	—	—	1·2	4·3	0·8	2·6	8·6	4·0	—
	£'000	—	—	—	—	1·0	2·9	1·5	5·5	6·8	4·3	—
USA	tonnes	4·4	35·1	163·6	138·2	44·4	90·5	50·9	35·3	15·5	14·8	38·1
	£'000	8·8	52·7	290·0	190·7	44·7	128·8	159·9	90·9	27·9	27·9	80·5
Other countries	tonnes	—	—	1·4	1·4	0·8	0·3	—	—	0·6	1·0	0·1
	£'000	—	—	2·9	1·8	0·8	0·2	—	—	0·3	1·0	0·3

Source: Trade Report
East African Customs and Excise

Footnote: — Nil or negligible.

Table 9

Crude papain exports from Tanzania

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Total	tonnes	52·5	91·3	65·2	51·5	35·7	41·1	27·9	29·4	40·5	36·2	14·1
	£'000	105·9	224·1	150·1	102·9	59·3	64·3	70·1	56·9	61·6	49·0	34·0
of which to:												
France	tonnes	3·6	2·0	3·9	3·5	1·8	5·0	1·6	0·9	0·5	1·6	1·1
	£'000	8·0	5·0	11·3	6·5	2·6	13·2	4·9	3·2	0·7	3·1	3·5
German Federal Republic	tonnes	2·6	3·4	1·9	1·8	1·7	1·7	2·4	0·7	1·5	0·4	0·8
	£'000	3·9	4·9	2·1	2·2	3·5	4·1	8·7	2·1	3·0	0·4	1·9
UK	tonnes	9·9	4·9	1·0	—	0·7	—	—	—	—	—	0·5
	£'000	17·3	10·8	2·2	—	0·7	—	0·1	0·1	—	—	1·4
Japan	tonnes	11·0	27·8	8·8	12·7	6·4	18·2	15·6	17·7	22·7	23·1	4·4
	£'000	23·0	82·7	23·0	23·3	7·5	24·2	36·4	24·5	26·1	20·7	12·8
Korean Republic	tonnes	—	—	—	—	—	0·3	0·2	0·5	0·5	0·5	—
	£'000	—	—	—	—	—	0·6	0·8	0·5	0·6	0·8	—
USA	tonnes	24·4	51·8	48·4	33·5	24·8	15·9	8·1	9·6	15·3	10·6	6·9
	£'000	51·4	116·8	108·5	70·9	44·5	22·2	19·2	26·5	31·1	24·0	12·7
Other countries	tonnes	1·0	1·4	1·2	—	0·3	—	—	—	—	—	0·4
	£'000	2·3	3·9	3·0	—	0·5	—	—	—	0·1	—	1·7

Source: Trade Report
East African Customs and Excise

Footnote: — Nil or negligible.

Table 10

White papain exports from Sri Lanka (Ceylon)

		1962	1963	1964	1965	1966	1967	1968	1969
Total	tonnes	2·8	17·1	38·3	35·4	35·0	9·2	6·8	14·0
	£'000	6·8	48·2	107·5	85·2	57·4	17·2	22·6	29·7
of which to:									
France	tonnes	0·2	3·9	0·5	0·7	1·2	—	—	—
	£'000	0·5	10·5	1·4	2·5	1·8	—	—	—
German Federal Republic	tonnes	—	—	1·9	—	1·3	0·7	0·8	1·0
	£'000	—	—	5·2	—	2·1	2·1	3·0	1·9
Italy	tonnes	1·0	—	0·5	—	—	—	—	—
	£'000	2·0	—	1·8	—	—	—	—	—
UK	tonnes	0·2	1·0	—	0·8	0·3	0·7	—	—
	£'000	0·6	3·6	—	2·7	0·5	1·5	—	—
Japan	tonnes	—	0·3	2·6	4·5	9·7	1·7	0·9	6·1
	£'000	—	0·7	7·3	11·1	14·1	3·7	2·9	12·6
South Africa	tonnes	—	—	0·4	1·3	0·7	0·9	1·3	1·4
	£'000	—	—	1·8	4·5	2·5	2·1	6·6	5·6
Argentina	tonnes	0·6	0·3	0·2	0·1	0·6	—	—	0·2
	£'000	1·3	0·7	0·5	0·5	1·1	—	—	0·8
USA	tonnes	0·7	11·5	32·2	27·8	20·6	5·1	3·6	4·4
	£'000	1·6	31·8	89·2	63·4	34·1	7·1	9·6	8·7
Other countries	tonnes	0·1	0·1	—	0·2	0·6	0·1	0·2	0·9
	£'000	0·8	0·9	0·3	0·5	1·2	0·7	0·5	0·1

Source: Ceylon Customs Returns
Government Press

Footnote: — Nil or negligible.

Table 11

Brown papain exports from Sri Lanka (Ceylon)

		1962	1963	1964	1965	1966	1967	1968	1969
Total	tonnes	28·4	34·1	44·1	32·8	10·1	10·1	13·1	10·9
	£'000	49·2	82·2	105·8	65·0	11·3	14·4	24·4	13·2
of which to:									
France	tonnes	1·0	1·4	1·0	1·2	—	—	—	—
	£'000	2·1	2·7	2·9	3·0	—	—	—	—
German Federal Republic	tonnes	4·1	0·5	—	—	—	—	—	—
	£'000	6·0	1·1	—	—	—	—	—	—
UK	tonnes	1·5	3·3	3·0	5·6	3·0	4·1	2·0	1·6
	£'000	2·7	9·5	8·2	10·3	3·1	4·9	3·5	1·7
Japan	tonnes	13·4	13·2	5·0	4·0	4·0	2·4	7·4	5·9
	£'000	22·3	37·6	12·7	8·6	4·0	2·5	11·2	5·7
Canada	tonnes	0·1	0·2	0·6	0·2	0·3	0·2	0·3	—
	£'000	0·3	0·7	1·9	0·5	0·5	0·3	0·9	—
USA	tonnes	7·1	13·5	33·1	19·5	—	1·0	—	—
	£'000	12·6	26·0	76·8	37·2	—	1·3	—	—
Australia	tonnes	1·0	1·1	1·1	2·0	2·0	2·1	2·0	3·0
	£'000	2·7	2·9	2·8	4·8	3·2	4·8	5·9	5·4
Other countries	tonnes	0·2	0·9	0·3	0·3	0·8	0·3	1·4	0·4
	£'000	0·5	1·7	0·5	0·6	0·5	0·6	2·9	0·4

Source: Ceylon Customs Returns
Government Press

Footnote: — Nil or negligible.

Table 12

Papain imports into the United States of America

		Papain only				Papain, dried Brewer's Yeast and Ficin							
		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Total from producing countries	tonnes	127·8	150·0	269·7	299·3	159·6	168·9	189·8	244·6	168·6	99·1	73·3	68·9
	£'000	221·4	419·7	799·3	699·0	287·5	404·4	611·3	515·2	296·2	203·4	238·8	404·7
of which from:													
Sri Lanka	tonnes	25·6	25·2	63·8	44·7	22·0	8·0	1·4	5·1	4·0	1·0	2·6	—
	£'000	45·0	63·4	200·2	109·1	42·9	11·9	3·5	10·9	7·0	1·5	9·5	—
Kenya	tonnes			34·2	17·3	18·8	12·9	26·8	42·7	22·7	10·3	3·1	1·3
	£'000			106·0	39·2	23·2	21·4	80·1	80·6	36·0	18·1	7·1	5·1
Uganda	tonnes	43·7	88·1	61·5	163·9	43·3	73·0	92·2	130·1	57·9	45·4	40·7	24·1
	£'000	73·1	262·8	174·3	357·1	71·6	208·2	311·2	268·0	98·7	95·0	127·3	92·5
Tanzania	tonnes			59·6	26·6	26·4	23·8	9·4	7·7	14·1	9·9	3·3	1·8
	£'000			174·2	78·9	60·9	47·1	31·3	22·6	36·7	18·9	7·6	6·0
Zaire Republic	tonnes	58·5	36·7	50·6	46·8	49·1	51·2	60·0	59·0	69·9	32·5	23·6	41·7
	£'000	103·3	93·5	144·6	114·7	88·9	115·8	185·2	133·1	117·8	69·9	87·3	301·1
Other countries	tonnes	7·7	8·2	10·9	8·3	598·7	597·9	691·9	794·6	716·4	873·2	1481·0	1551·3
	£'000	14·5	24·1	31·1	17·7	75·5	84·6	266·6	382·9	184·5	239·4	485·3	546·2
GRAND TOTAL	tonnes	135·5	158·2	280·6	307·6	758·3	766·8	881·7	1039·2	885·0	972·3	1554·3	1620·2
	£'000	235·9	443·8	830·4	716·7	363·0	489·0	877·9	898·1	480·7	432·8	724·1	850·9

Source: Bureau of the Census Report FT 135
Department of Commerce

Table 13

Papain imports into Japan

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Total	tonnes	39·5	50·9	34·4	29·3	40·8	39·3	59·8	46·3	70·7	68·9	84·6	86·9
	£'000	101·2	174·4	115·1	75·0	62·6	71·0	182·9	95·2	138·3	162·3	338·9	407·7
of which from:													
Sri Lanka (Ceylon)	tonnes	12·0	14·3	6·1	9·8	15·2	2·8	8·7	10·1	10·5	3·9	12·4	15·9
	£'000	29·0	41·3	17·8	26·3	21·1	3·8	15·6	15·7	22·8	8·6	40·1	92·1
Kenya	tonnes	0·9	—	—	—	2·1	4·0	2·5	—	—	—	—	7·3
	£'000	2·5	—	—	—	3·3	6·7	8·2	—	—	—	—	35·5
Tanzania	tonnes	15·9	31·5	18·6	12·3	10·4	17·9	22·4	16·1	26·6	26·6	2·8	6·5
	£'000	41·1	113·6	64·4	31·1	14·7	30·9	68·9	37·1	48·1	52·3	11·6	30·2
Uganda	tonnes	—	—	3·4	3·0	11·9	11·9	15·5	18·1	32·0	22·2	59·0	29·4
	£'000	—	—	11·7	7·5	21·0	23·2	55·8	38·8	64·8	56·0	242·2	96·9
Congo (Brazz)	tonnes	1·8	2·0	1·0	3·9	1·0	1·5	8·1	—	1·0	—	—	—
	£'000	5·2	7·7	4·1	8·9	2·1	3·4	26·2	—	1·3	—	—	—
Zaire Republic	tonnes	8·7	3·0	5·2	—	—	—	2·3	1·9	0·5	12·8	10·4	25·2
	£'000	23·0	11·7	16·8	—	—	—	7·3	3·1	0·8	38·5	45·0	141·5
Taiwan (Formosa)	tonnes	—	—	0·1	0·1	0·2	0·4	0·3	0·1	—	—	—	—
	£'000	—	—	0·2	0·2	0·4	1·1	0·9	0·5	—	—	—	—
Australia	tonnes	—	—	—	—	—	—	—	—	—	3·1	—	—
	£'000	—	—	—	—	—	—	—	—	—	5·6	—	—
Other countries	tonnes	0·2	0·1	—	0·2	—	0·8	—	—	0·1	0·3	—	2·6
	£'000	0·4	0·1	0·1	1·0	—	1·9	—	—	0·5	1·3	—	11·6

Source: Trade of Japan, Japan Tariff Assn.

Footnote: — Nill or negligible.

Table 14

Apparent imports of papain into the United Kingdom

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Total	tonnes	13·8	19·0	15·3	25·4	16·4	15·0	15·8	22·3	16·8	16·1
	£'000	26·8	54·6	39·2	49·6	16·1	21·9	33·9	30·5	17·5	17·3
of which from:											
Kenya, Uganda & Tanzania	tonnes	12·3	14·8	12·3	19·0	13·1	10·2	13·8	20·7	16·8	16·1
	£'000	24·1	41·5	31·0	36·6	12·5	15·5	30·4	28·8	17·5	17·3
Sri Lanka (white)	tonnes		0·9	—	0·8	0·3	0·7	—	—	..	..
	£'000		3·6	—	2·7	0·5	1·5	—	—	..	..
		1·5			5·6						
		2·7									
Sri Lanka (brown)	tonnes		3·3	3·0		3·0	4·1	2·0	1·6	..	..
	£'000		9·5	8·2	10·3	3·1	4·9	3·5	1·7	..	..

Source: Export Statistics of the countries shown

Footnote: — Nil or negligible
.. Not available

Table 15

Papain imports into the Korean Republic

		1971
Total	tonnes	6·5
	£ '000	34·9
of which from:		
France	tonnes	1·0
	£ '000	5·1
Japan	tonnes	1·4
	£ '000	6·6
USA	tonnes	4·0
	£ '000	22·5
Other countries	tonnes	0·1
	£ '000	0·7

Source: Yearbook of Foreign Trade, 1971, Office of Customs Administration

Table 16

White Papain: prices fob Colombo quarterly averages and annual range

	Pence per kg				*Range*	
	I	II	III	IV	Low	High
1962	196	149	141	199	132	215
1963	223	251	273	281	198	289
1964	254	240	209	187	182	265
1965	175	157	124	112	107	182
1966	102	85	58	58	58	107
1967	—	—	—	—	—	—
1968	368	310	402	349	219	518
1969	300	278	298	211	178	438
1970	225	205	196	206	179	249

Source: Ceylon Trade Journal **Footnote:** — Not quoted

Table 17

East Africa No 1 Papain: prices cif United Kingdom quarterly averages and annual range

	Pence per kg				*Range*	
	I	II	III	IV	Low	High
1962	—	331	—	287	287	331
1963	353	356	410	427	320	427
1964	375	354	360	386	309	386
1965	267	267	256	245	245	267
1966	193	204	200	136	121	204
1967	121	182	281	303	121	331
1968	—	380	380	380	380	380
1969	380	—	—	—	—	—
1970–72	—	—	—	—	—	—

Source: The Public Ledger **Footnote:** — Not quoted

Table 18

Papain imports into the United States and Japan from producing countries

	INTO USA		INTO JAPAN		TOTAL	UNIT VALUE
	Tonnes	Value £'000	Tonnes	Value £'000	Tonnes	Pence per kg
1950	104·0	130·5	1·7	2·1	105·7	125
1951	77·4	231·7	3·6	11·2	81·0	300
1952	127·3	447·1	3·6	13·3	130·9	352
1953	228·8	748·9	3·5	12·5	232·3	328
1954	314·6	480·7	7·6	11·0	322·2	153
1955	154·6	233·1	5·8	8·1	160·4	150
1956	109·1	226·0	4·2	10·9	113·3	209
1957	115·6	339·8	12·5	29·2	128·1	288
1958	142·7	453·1	12·4	36·1	155·1	315
1959	197·9	378·7	17·0	26·6	214·9	189
1960	183·2	282·7	22·7	24·9	205·9	149
1961	130·8	190·7	26·6	44·8	157·4	150
1962	127·8	221·4	37·5	95·6	165·3	192
1963	150·0	419·7	48·8	166·6	198·8	295
1964	269·7	799·3	33·3	110·7	303·0	300
1965	299·3	699·0	25·1	64·9	324·4	235
1966	159·6	287·5	39·6	60·1	199·2	174
1967	168·9	404·4	36·6	64·6	205·5	228
1968	189·8	611·3	51·4	155·8	241·2	318
1969	244·6	515·2	46·2	94·7	290·8	210
1970	168·6	296·2	69·6	136·5	238·2	182
1971	99·1	203·4	65·5	155·4	164·6	218

Sources: USA Bureau of the Census Report FT135
Dept. of Commerce;
Japan 1962 to 1971 Trade of Japan,
Japan Tariff Assn.
1950 to 1961 Exports from Ceylon and East Africa consigned to Japan.

Table 19

United States papain imports from producing countries, 1947–71, and projection

			CYCLIC CURVES	
	QUANTITY tonnes	VALUE pence/kg	QUANTITY tonnes	VALUE pence/kg
1947	148·9	287·5	111·2	265·3
1948	197·0	181·3	185·0	267·5
1949	215·7	134·6	222·5	197·6
1950	104·0	125·4	173·6	153·7
1951	77·4	300·8	107·7	197·8
1952	127·3	351·3	117·7	270·2
1953	228·8	327·3	191·5	272·2
1954	314·6	152·8	229·0	202·3
1955	154·6	150·8	180·1	158·4
1956	109·1	207·1	114·2	202·5
1957	115·6	294·1	124·2	274·9
1958	142·7	317·7	198·0	276·9
1959	197·9	191·4	235·5	207·0
1960	183·2	154·4	186·6	163·1
1961	130·8	145·8	120·7	207·2
1962	177·8	173·2	130·7	279·6
1963	150·0	279·8	204·5	281·6
1964	269·7	296·4	242·0	211·7
1965	299·3	233·5	193·1	167·8
1966	159·6	180·0	127·2	211·9
1967	168·9	239·5	137·2	284·3
1968	189·8	322·0	211·0	286·3
1969	244·6	218·0	248·5	216·4
1970	168·6	175·7	199·6	172·5
1971	99·1	205·1	133·7	216·6
Projection 1972			143·7	288·0
1973			217·5	291·0
1974			255·0	221·1
1975			206·1	177·2
1976			140·2	221·3

Source: Bureau of the Census Report FT135, Department of Commerce.

Footnote: Curves fitted by Fourier analysis. See figures 5 and 6.

Figures

Figure 1
Papain: Indigenous exports 1950 to 1971

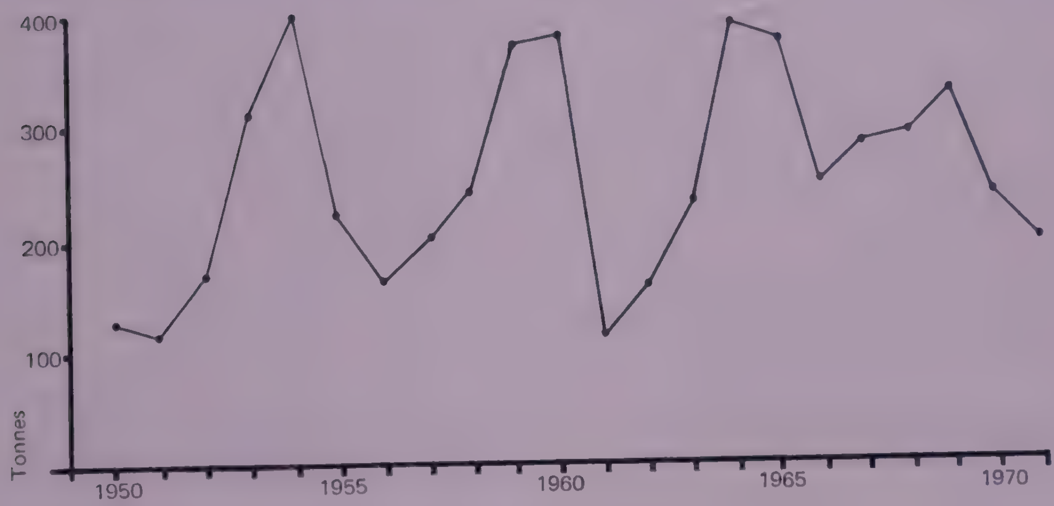
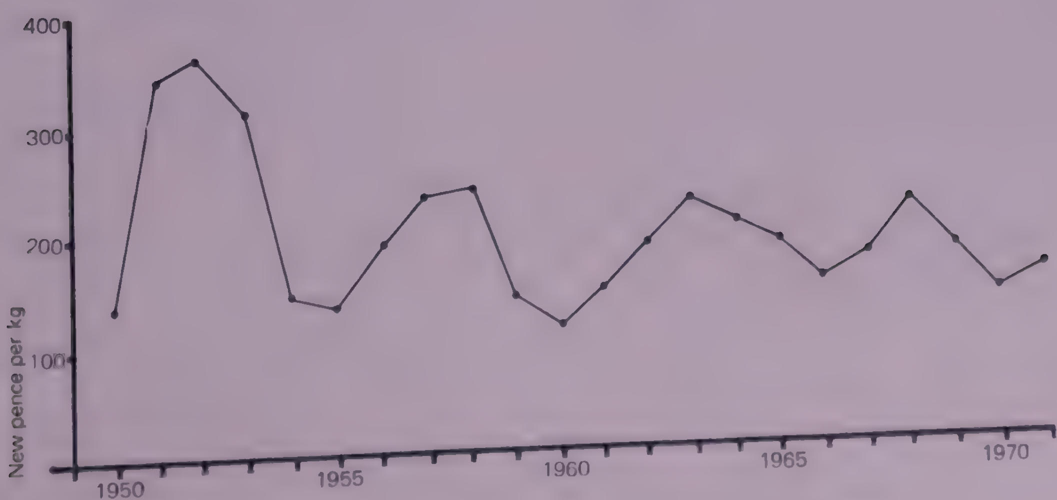


Figure 2
Papain: Average export values 1950 to 1971



Sources: Export statistics of producing countries, and imports into United States and Japan

Figure 3
Papain: Imports into the USA and Japan from producing countries

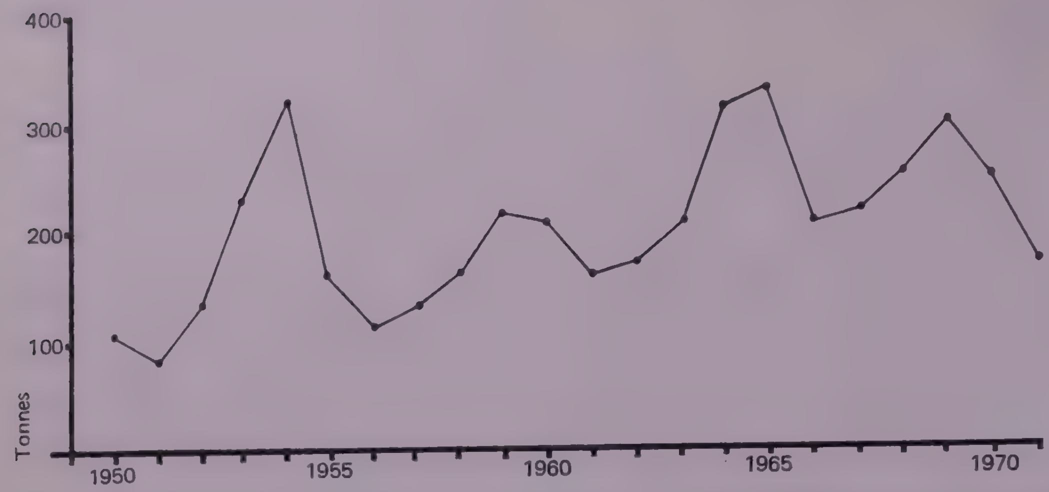
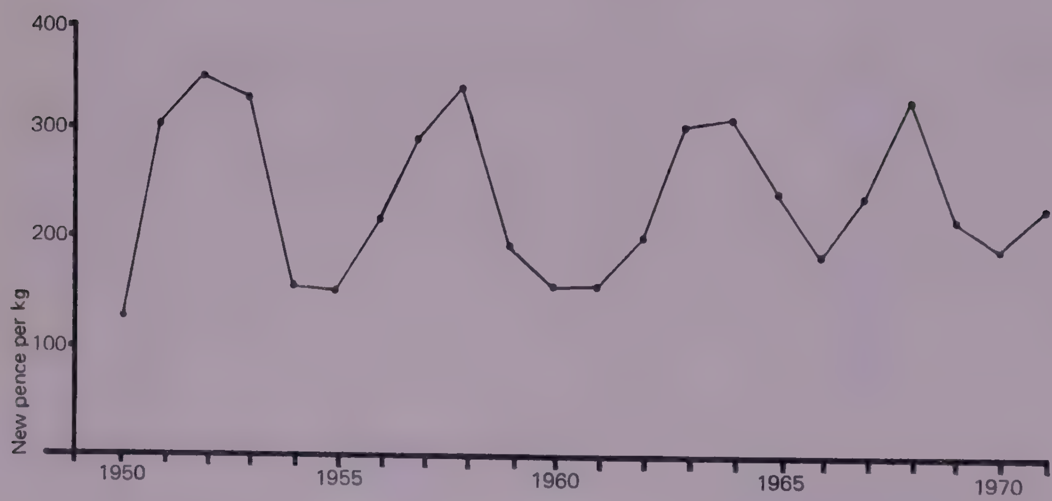


Figure 4
Papain: Average import values into the USA and Japan



Source: Data of Table 18

Figure 5
Papain: USA imports from producing countries 1947 to 1971

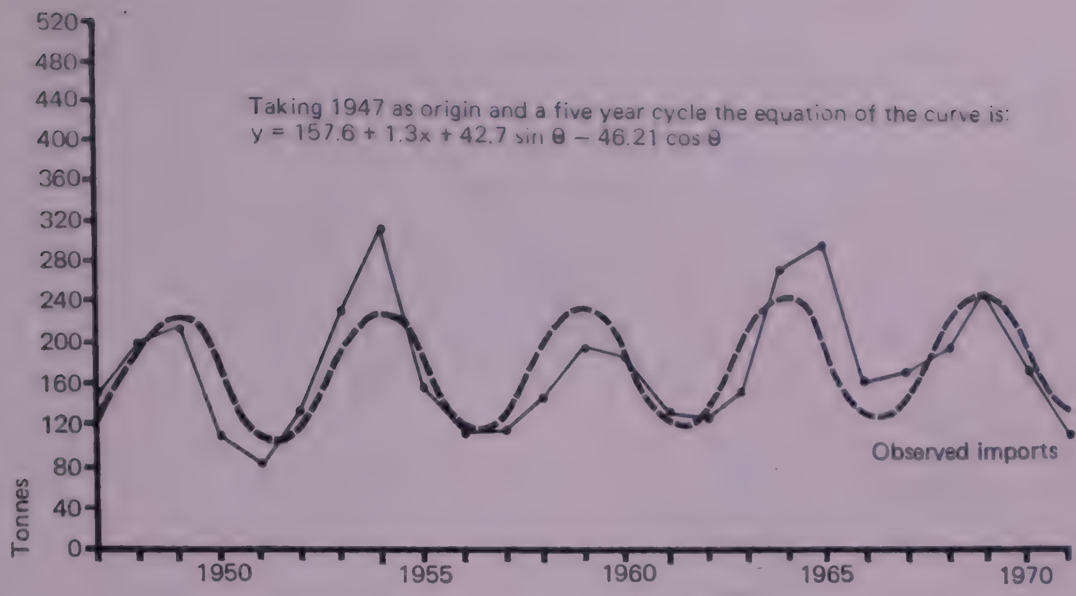
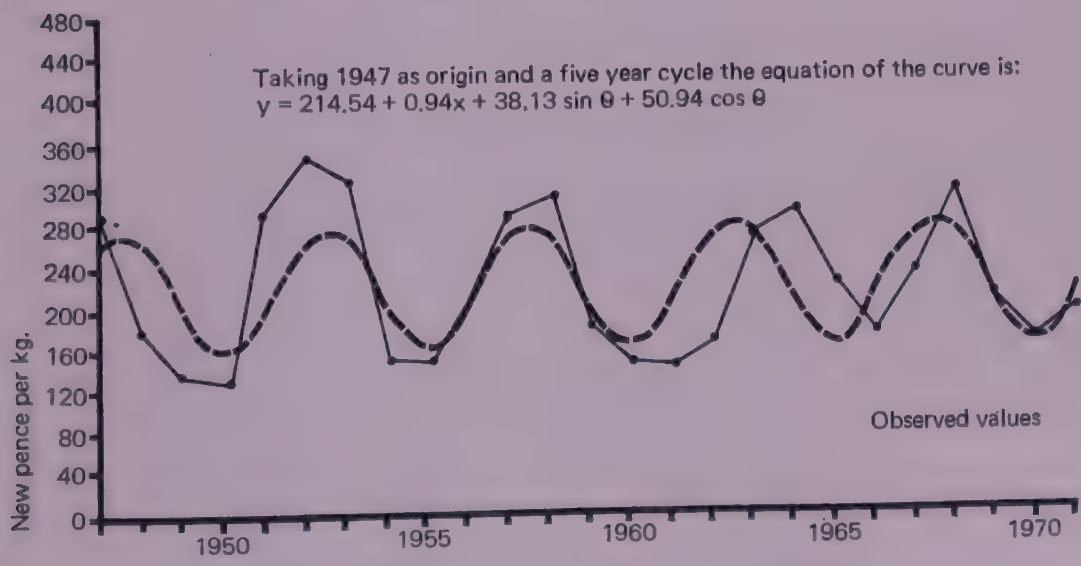
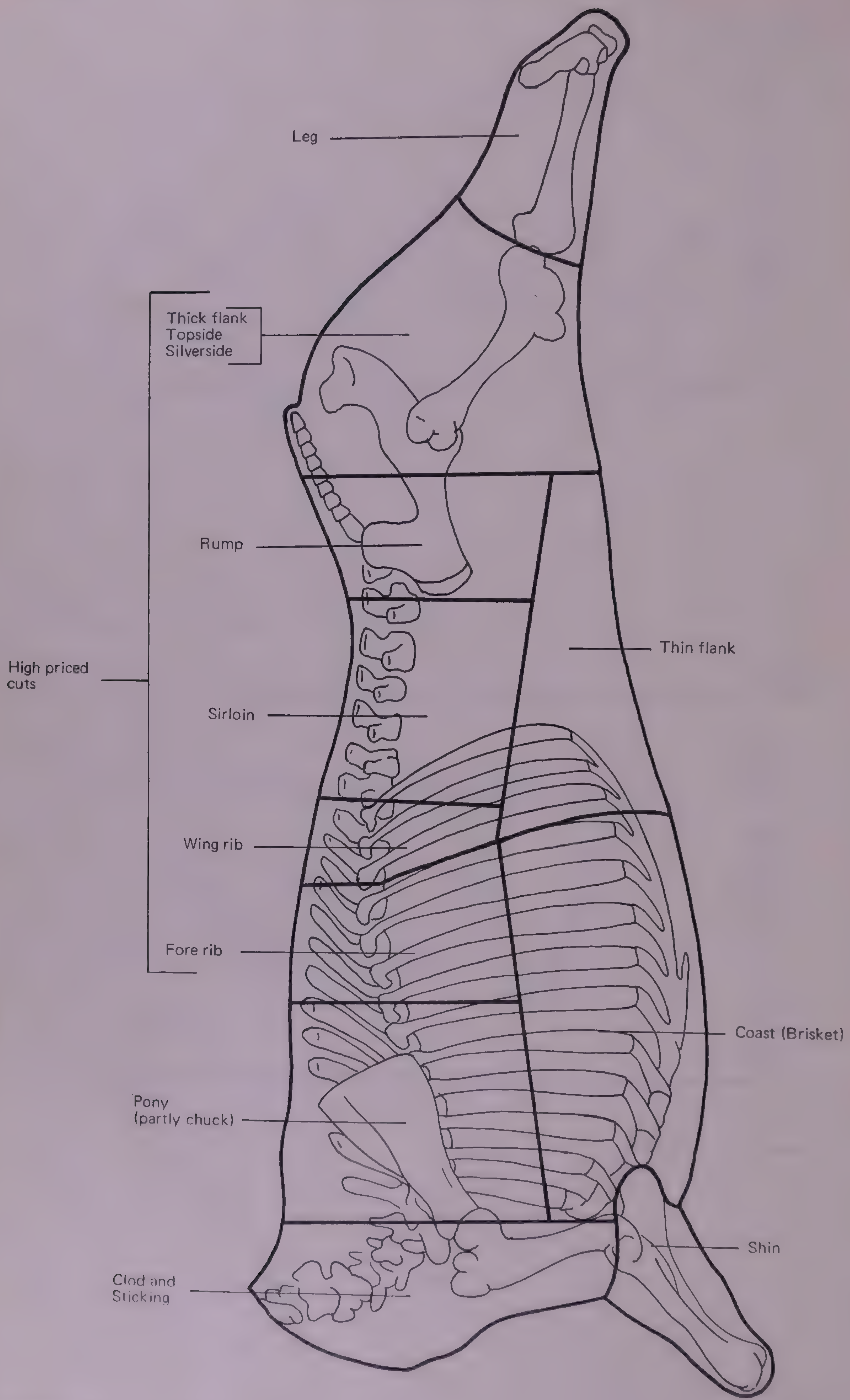


Figure 6
Papain: Unit values of USA imports from producing countries 1947 to 1971



Source: Data of Table 19

Figure 7
Standardised joints in MLC beef dissection technique



Source: Meat and Livestock Commission